

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Armand P. Neukermans, et al.

Docket no.: 2149A

Serial no.: (Unknown)

Filed : Herewith

For : FLEXIBLE, MODULAR, COMPACT
FIBER OPTIC SWITCH

Art Unit : Unknown

Examiner: Unknown

Hon. Commissioner of Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

In the Specification

Please amend the specification of the application as follows:
page 1, line 3, add:

This is a continuation of application Serial No. 09/446,540 filed under 37 C.F.R. § 371 on December 21, 1999, and which claims priority from Patent Cooperation Treaty ("PCT") international application PCT/US99/21139 that was filed with the United States Patent and Trade-mark Office ("USPTO") Receiving Office (RO/US) on September 15, 1999.

page 17, line 23, delete "arrangements" and substitute there-
fore --arrangement--;

page 18, line 38, delete "exhibit" and substitute therefore
--require--;

page 20, line 5, delete "and the optical fiber";
line 6, delete "collimator assembly 134";

page 26, lines 6 and 7, /

delete "A United States patent application
and a Patent Cooperation Treaty ("PCT") in-
ternational patent application"
and substitute therefor

~~United States Patent Application Serial No.~~

09/388,772 and published Patent Cooperation
Treaty ("PCT") international patent applica-
tion WO 00/13210--;

line 11, delete "the" and substitute therefore --in
greater detail--;

page 28, line 3, following "switching module 100" insert

--,--;

line 9, delete "176" and substitute therefore

--182--;

line 10, delete "176" and substitute therefore

--182--; and

page 39, line 3, delete "The" and substitute therefor

--Referring now to FIGs. 22a-22c, the--.

In the Claims

Please cancel claims 1-20 without prejudice, and substitute
the following claims 21-78 for those previously pending in the
application.

Q3 21. (New) A light beam deflector assembly adapted for use in a fiber optic switching module that includes:

5 a first and a second group of collimator receptacles which are separated from each other at opposite ends of a free space optical path with each collimator receptacle being respectively adapted for receiving and fixing an end of an optical fiber; and

10 lenses that are supported within the fiber optic switching module each juxtaposed with the end of one optical fiber fixable in the collimator receptacles, and disposed with respect to the end of that optical fiber so a beam of light emittable from the end passes through the lens to propagate as a quasi-collimated beam within the optical path from the lens toward the second or toward the first group of collimator
15 receptacles;

20 the light beam deflector assembly being positionable along the optical path between the groups of collimator receptacles so at least one quasi-collimated beam of light propagatable from at least one of the lenses impinges thereon, the light beam deflector assembly comprising:

(a) a substrate (212); and

(b) a plurality of reflective light beam deflectors that are fixed to a surface of said substrate (212) which respectively:

i. are:

25 (1) associated with one of the lenses;

Q3
Cont'd

(2) positioned so the quasi-collimated beam of light propagatable from the associated lens impinges upon one of said light beam deflectors to be reflected therefrom; and

30

(3) energizable by drive signals supplied to said substrate (212) for orienting the light beam deflectors fixed thereto so the quasi-collimated beam of light propagatable from the associated lens, that reflects off the one of said light beam deflectors, also reflects off another selected light beam deflector that is also:

35

A. positionable along the optical path between the groups of collimator receptacles;

B. energizable by drive signals supplied to said fiber optic switching module; and

40

C. associated with one of the lenses;

whereby a pair of light beam deflectors, one light beam deflector of the pair included in the light beam deflector assembly, when selected and oriented by drive signals supplied respectively thereto, establish an optical coupling by which a beam
45 of light propagating through the optical path from the end of one optical fiber fixable in the collimator receptacle either of the first or of the second group is reflectable sequentially off the pair of energized light beam deflectors into a selected one of the optical fibers fixable at the second or at the first group of
50 collimator receptacles.

A3
contd

22. (New) The light beam deflector assembly of claim 21 wherein the substrate (212) is formed from an electrically insulating material.

23. (New) The light beam deflector assembly of claim 22 wherein said substrate (212) has electrically conductive electrodes formed on the surface to which said light beam deflectors are fixed, and wherein the drive signals supplied to said substrate (212) generate an electrostatic force between said electrodes and said light beam deflector to energize orientation of said light beam deflectors fixed to said substrate (212).

24. (New) The light beam deflector assembly of claim 23 wherein areas on said electrodes of possible contact with said light beam deflectors are at least partially overcoated with electrically insulating material.

25. (New) The light beam deflector assembly of claim 23 wherein areas on said electrodes of possible contact with said light beam deflectors are pierced by holes.

26. (New) The light beam deflector assembly of claim 22 wherein said light beam deflectors are organized as a group.

A3
cancel

27. (New) The light beam deflector assembly of claim 26
5 wherein the substrate (212) has a width that does not substantially
exceed a width of the group of light beam deflectors fixed thereto.

Sub
B1

28. (New) The light beam deflector assembly of claim 27
wherein an of the light beam deflector assembly that is free of
light beam deflectors is juxtaposable with an of another light
beam deflector assembly that is includable in the fiber optic
5 switching module, positionable along the optical path, and also
free of light beam deflectors.

29. (New) The light beam deflector assembly of claim 28
wherein light beam deflectors included therein are offsetable from
light beam deflectors included in a second light beam deflector
assembly that is juxtaposable therewith.

30. (New) The light beam deflector assembly of claim 26
wherein the group of light beam deflectors is rectangularly-shaped,
and wherein each light beam deflector fixed to said substrate (212)
is supported by hinges for rotation about an axis that is oriented
5 substantially parallel to an axis of the rectangularly-shaped group
of light beam deflectors.

31. (New) The light beam deflector assembly of claim 26
wherein said substrate (212) is elongated, and wherein each light
beam deflector fixed to said substrate (212) is supported by hinges

03
Cont'd

for rotation about an axis that is oriented substantially perpen-
5 dicular to a longitudinal axis of said elongated substrate (212).

32. (New) The light beam deflector assembly of claim 26
wherein each light beam deflector fixed to said substrate (212) is
supported by hinges for rotation about an axis that is oriented at
an angle of approximately forty-five degrees (45°) to an axis of
5 the group of light beam deflectors.

33. (New) The light beam deflector assembly of claim 22
wherein the substrate (212) is fabricated from material selected
from a group consisting of silicon, polysilicon, Pyrex glass,
aluminum oxide and aluminum nitride.

34. (New) The light beam deflector assembly of claim 33
wherein the substrate (212) is pierced by insulated,
electrically-conductive vias that provide electrical connections to
said light beam deflectors.

35. (New) The light beam deflector assembly of claim 33
wherein the substrate (212) has integrated circuits integrated
therein or thereon.

36. (New) The light beam deflector assembly of claim 35
wherein said substrate (212) has electrically conductive electrodes
formed on the surface to which said light beam deflectors are

A3
Contd

5 fixed, and wherein the drive signals supplied to said substrate (212) for each of said light beam deflectors are received by amplifiers that are included in the light beam deflector assembly for supplying voltage signals to said electrodes to generate an electrostatic force between said electrodes and said adjacent light beam deflector.

Sub
B2

37. (New) The light beam deflector assembly of claim 35 wherein the integrated circuits include amplifiers that receive s which indicate light beam deflector orientation.

38. (New) The light beam deflector assembly of claim 37 wherein each light beam deflector fixed to said substrate (212) is supported for rotation by hinges which include at least one torsion sensor for sensing light beam deflector orientation, the torsion sensors of said light beam deflectors supplying the s to at least one amplifier included in the light beam deflector assembly.

39. (New) The light beam deflector assembly of claim 21 wherein the substrate (212) is pierced by insulated, electrically-conductive vias that provide electrical connections to said light beam deflectors.

40. (New) The light beam deflector assembly of claim 21 wherein said light beam deflectors are monolithically fabricated from a single-crystal semiconductor layer of a silicon wafer (162).

A3
contd

41. (New) The light beam deflector assembly of claim 40 wherein several light beam deflectors fixed to said substrate (212) are monolithically fabricated as a one-piece group from the single-crystal semiconductor layer of a single silicon wafer (162).

42. (New) The light beam deflector assembly of claim 41 wherein the substrate (212) has a width that does not substantially exceed a width of the group of light beam deflectors fixed thereto.

Sub
B3

00700336
5
12
00700336

43. (New) The light beam deflector assembly of claim 42 wherein an of the light beam deflector assembly that is free of light beam deflectors is juxtaposable with an of another light beam deflector assembly that is includable in the fiber optic switching module, positionable along the optical path, and also free of light beam deflectors.

44. (New) The light beam deflector assembly of claim 43 wherein light beam deflectors included therein are offsetable from light beam deflectors included in a second light beam deflector assembly that is juxtaposable therewith.

45. (New) The light beam deflector assembly of claim 41 wherein at least two, one-piece groups of light beam deflectors are fixed to said substrate (212).

A3
Contd

46. (New) The light beam deflector assembly of claim 40 wherein light beam deflectors respectively include:

an outer frame;

first torsional hinges that project inwardly from the outer
5 frame;

an inner frame supported by the first torsional hinges for rotation about a first axis;

second torsional hinges that project inwardly from the inner frame; and

10 a central plate that is supported by the second torsional hinges for rotation about a second axis that is not oriented parallel to the first axis, and that has a reflective mirror surface formed thereon.

47. (New) The light beam deflector assembly of claim 46 wherein the central plate of light beam deflectors has a width that exceeds a height of the central plate measured perpendicular to the width thereof.

48. (New) The light beam deflector assembly of claim 47 wherein the width of said light beam deflector equals approximately 1.4 times the height thereof.

49. (New) The light beam deflector assembly of claim 40 wherein the silicon wafer (162) includes a device layer (166) and

A3
Contd

a handle layer (168), and said light beam deflectors are formed in the device layer (166) of the silicon wafer (162).

50. (New) The light beam deflector assembly of claim 49 wherein said light beam deflectors are fixed to the substrate (212) with the device layer (166) of the silicon wafer (162) disposed nearest to the substrate (212), and the handle layer (168) disposed
5 further from the substrate (212).

51. (New) The light beam deflector assembly of claim 50 wherein the handle layer (168) surrounding each of the light beam deflectors is coated with an anti reflection layer to absorb stray light from the quasi-collimated beam of light impinging thereon.

52. (New) The light beam deflector assembly of claim 49 wherein hinges which support said light beam deflector for rotation about an axis, that are also formed in the device layer (166) of the silicon wafer (162), are thinner than the device layer (166) of
5 the silicon wafer (162).

53. (New) The light beam deflector assembly of claim 49 wherein a surface of said light beam deflector upon which the quasi-collimated beam of light does not directly impinge has a cavity formed therein which is surrounded by a reinforcing rim.

A3
Contd

54. (New) The light beam deflector assembly of claim 21 further comprising a plurality of light beam deflector orientation sensors at least one of which is associated respectively with each of said light beam deflectors.

55. (New) The light beam deflector assembly of claim 54 wherein each light beam deflector fixed to said substrate (212) is supported for rotation by hinges, and wherein said light beam deflector orientation sensor includes at least one torsion sensor
5 formed in the hinges.

56. (New) The light beam deflector assembly of claim 21 wherein the quasi-collimated beam of light impinges obliquely upon the light beam deflector to reflect obliquely therefrom.

57. (New) The light beam deflector assembly of claim 56 wherein each light beam deflector has a width in a plane established by the impinging and reflected quasi-collimated beam of light which exceeds a height perpendicular to the plane.

58. (New) The light beam deflector assembly of claim 57 wherein the width of said light beam deflector equals approximately 1.4 times the height thereof.

59. (New) The light beam deflector assembly of claim 21 adapted for overlapping with another light beam deflector assembly

93
contd

that is includable in the fiber optic switching module and positionable along the optical path.

60. (New) The light beam deflector assembly of claim 21 adapted for coupling to a ribbon cable by which the drive signals are supplied to said light beam deflectors.

61. (New) The light beam deflector assembly of claim 21 wherein a mirror surface is disposed along a surface of said substrate (212) which is distal from the surface thereof to which said light beam deflectors are fixed, the light beam deflector assembly being:

juxtaposable with a second light beam deflector assembly includable in the fiber optic switching module and positionable in the optical path thereof, the second light beam deflector assembly also having a mirror surface disposed along a surface of the substrate (212) of the second light beam deflector assembly; and

configurable with respect to the mirror surface of the second light beam deflector assembly so the quasi-collimated beam of light that impinges upon light beam deflector first impinges on and is reflected from the mirror surface disposed on the adjacent substrate (212) of the second light beam deflector assembly.

43
Contd

62. (New) The light beam deflector assembly of claim 21 wherein light beam deflectors respectively include:

an outer frame;

first torsional hinges that project inwardly from the outer
5 frame;

an inner frame supported by the first torsional hinges for rotation about a first axis;

second torsional hinges that project inwardly from the inner frame; and

10 a central plate that is supported by the second torsional hinges for rotation about a second axis that is not oriented parallel to the first axis, and that has a reflective mirror surface formed thereon.

63. (New) The light beam deflector assembly of claim 62 wherein said light beam deflectors are organized as a group having an axis to which the second axis of light beam deflectors is oriented substantially parallel.

64. (New) The light beam deflector assembly of claim 63 wherein the first axis of light beam deflectors is oriented substantially perpendicular to an axis of the group of said light beam deflectors.

65. (New) The light beam deflector assembly of claim 63 wherein the central plate of light beam deflectors has a width

03
Cont'd

perpendicular to the axis of the group of said light beam deflec-
tors that exceeds a height of the central plate parallel to the
5 axis of the group of said light beam deflectors.

66. (New) The light beam deflector assembly of claim 65
wherein the width of said light beam deflector equals approximately
1.4 times the height thereof.

67. (New) A flip-chip light beam deflector assembly
comprising:

a substrate (212); and

10 a reflective light beam deflector that is monolithically
fabricated from a single-crystal semiconductor layer of a silicon
wafer (162) that includes a device layer (166) and a handle layer
(168), said light beam deflector being fixed to a surface of said
substrate (212) with the device layer (166) of the silicon wafer
(162) disposed nearest to the substrate (212), and the handle layer
(168) disposed further from the substrate (212), said light beam
deflector being energizable by a drive signal supplied to said
substrate (212) for orienting said light beam deflector.

68. (New) The flip-chip light beam deflector assembly of
claim 67 wherein said light beam deflector is formed in the device
layer (166) of the silicon wafer (162).

A3
contd

69. (New) The flip-chip light beam deflector assembly of claim 67 wherein the substrate (212) is fabricated from material selected from a group consisting of silicon, polysilicon, Pyrex glass, aluminum oxide and aluminum nitride.

70. (New) The flip-chip light beam deflector assembly of claim 69 wherein the substrate (212) is pierced by insulated, electrically-conductive vias that provide electrical connections to said light beam deflector.

71. (New) The flip-chip light beam deflector assembly of claim 69 wherein the substrate (212) has an integrated circuit therein or thereon.

72. (New) The flip-chip light beam deflector assembly of claim 71 wherein said substrate (212) has an electrically conductive electrode formed on the surface thereof to which said light beam deflector is fixed, and wherein the drive signal supplied to said substrate (212) is received by an amplifier that is included in the integrated circuit for supplying a voltage signal to said electrode to generate an electrostatic force between said electrode and said light beam deflector adjacent thereto.

Sub
B4

73. (New) The flip-chip light beam deflector assembly of claim 71 wherein the integrated circuit includes an amplifier that receives an which indicates light beam deflector orientation.

A3
Cont'd
Sub
B4

74. (New) The flip-chip light beam deflector assembly of claim 73 wherein said light beam deflector fixed to said substrate (212) is supported for rotation by hinges which include at least one torsion sensor for sensing light beam deflector orientation, the torsion sensor of said light beam deflector supplying the to at least one amplifier.

75. (New) The flip-chip light beam deflector assembly of claim 67 wherein the handle layer (168) surrounding each of the light beam deflectors is coated with an anti reflection layer to absorb stray light impinging thereon.

76. (New) A light beam deflector assembly adapted for use in a fiber optic switching module that includes:

a first and a second group of collimator receptacles which are separated from each other at opposite ends of a free space optical path with each collimator receptacles being respectively adapted for receiving and fixing an end of an optical fiber; and

lenses that are supported within the fiber optic switching module each juxtaposed with the end of one optical fiber fixable in the collimator receptacles, and disposed with respect to the end of that optical fiber so a beam of light emittable from the end passes through the lens to propagate as a quasi-collimated beam within the optical path from the lens

A3
cont'd

15

toward the second or toward the first group of collimator receptacles;

the light beam deflector assembly being positionable along the optical path between the groups of collimator receptacles so at least one quasi-collimated beam of light propagatable from at least one of the lenses impinges thereon, the light beam deflector assembly comprising:

(a) a substrate (212); and

(b) a plurality of reflective light beam deflectors that are fixed to a surface of said substrate (212) which respectively:

i. are:

(1) associated with one of the lenses;

(2) positioned so the quasi-collimated beam of light propagatable from the associated lens impinges upon one of said light beam deflectors to be reflected therefrom; and

(3) energizable by drive signals supplied to said substrate (212) for orienting the light beam deflectors fixed thereto so the quasi-collimated beam of light propagatable from the associated lens, that reflects off the one of said light beam deflectors, also reflects off another selected light beam deflector that is also:

A. positionable along the optical path between the groups of collimator receptacles;

B. energizable by drive signals supplied to said fiber optic switching module; and

C. associated with one of the lenses; and

ii. include an orientation sensor for generating an orientation signal which indicates orientation of said light beam deflector; and

(c) an amplifier which receives the orientation signal from the orientation sensor of said light beam deflector;

whereby a pair of light beam deflectors, one light beam deflector of the pair included in the light beam deflector assembly, when selected and oriented by drive signals supplied respectively thereto, establish an optical coupling by which a beam of light propagating through the optical path from the end of one optical fiber fixable in the collimator receptacle either of the first or of the second group is reflectable sequentially off the pair of energized light beam deflectors into a selected one of the optical fibers fixable at the second or at the first group of collimator receptacles.

77. (New) The light beam deflector assembly of claim 76 wherein each light beam deflector fixed to said substrate (212) is supported for rotation by hinges, and wherein said light beam deflector orientation sensor includes at least one torsion sensor formed in one of the hinges.

78. (New) The light beam deflector assembly of claim 76 wherein said substrate (212) has electrically conductive electrodes formed on the surface to which said light beam deflectors are

Q3
end

fixed, and wherein the drive signals supplied to said substrate
5 (212) for each of said light beam deflectors are received by
amplifiers that are included in the light beam deflector assembly
for supplying voltage signals to said electrodes to generate an
electrostatic force between said electrodes and said immediately
adjacent light beam deflector.

In the Drawings

Forwarded herewith are a set of formal drawings which replace
the set of informal drawings submitted when the parent PCT patent
application was filed on September 15, 1999. The replacement set
of formal drawings amend FIGs. 7, 10, 15 and 23 of the application
as originally filed. Copies of the original FIGs. 7, 10, 15 and 23
and of the substitute sheets containing amended FIGs. 7, 10, 15 and
23 that have been annotated to indicate where revisions have been
made also accompany this preliminary amendment.

REMARKS

Amendments To The Specification

The amendments to the specification set forth above:

1. claim priority from a parent application;
2. correct grammatical and textual errors;
3. conform the terminology used in the specification to that
used in claims; and
4. increase the specification's precision.

Amendment Of The Claims

This preliminary amendment presents new claims to more particularly point out and distinctly claim a particular aspect of the subject matter which Applicants regard as their invention.

Amendments To The Drawings

FIG. 7 has been amended to change an erroneous reference number "116b" located in the upper left hand corner of the drawing to the correct reference number "116a."

FIG. 10 has been amended by adding the reference number "152" at the right hand side of the FIG. thereby conforming FIG. 10 to the illustrations of FIGs. 6, 7 and 9 of the application as originally filed.

FIG. 15 has been amended to add reference numbers thereto which identify torsional flexure hinges 182 depicted therein thus conforming FIG. 15 to the text of the specification that appears on page 28 in lines 8-11.

FIG. 23 has been amended by adding the reference numbers "312" at four locations thereby conforming that FIG. to the text of the patent application beginning at line 34 on page 40 of the application as originally filed.

Applicants respectfully submit that the amendments to the drawings described above add no new matter to the application as originally filed.

[illegible]

Respectfully submitted,

Date November 30, 2000

Attorney for Applicants

ABSTRACT

A fiber optic switch (400) includes a fiber optic switching module (100) that receives and fixes ends (104) of optical fibers (106). The module (100) includes numerous reflective light beam deflectors (172) which may be selected as pairs for coupling a beam of light (108) between a pair of optical fibers (106). The module (100) also produces orientation signals from each deflector (172) which indicate its orientation. A portcard (406) included in the switch (400) supplies drive signals to the module (100) for orienting at least one deflector (172). The portcard (406) also receives the orientation signals produced by that deflector (172) together with coordinates that specify an orientation for the deflector (172). The portcard (406) compares the received coordinates with the orientation signals received from the deflector (172) and adjusts the drive signals supplied to the module (100) to reduce any difference between the received coordinates and the orientation signals. The switch (400) also employs optical alignment to precisely orient pairs deflectors (172) coupling a beam of light (108) between optical fibers (106).

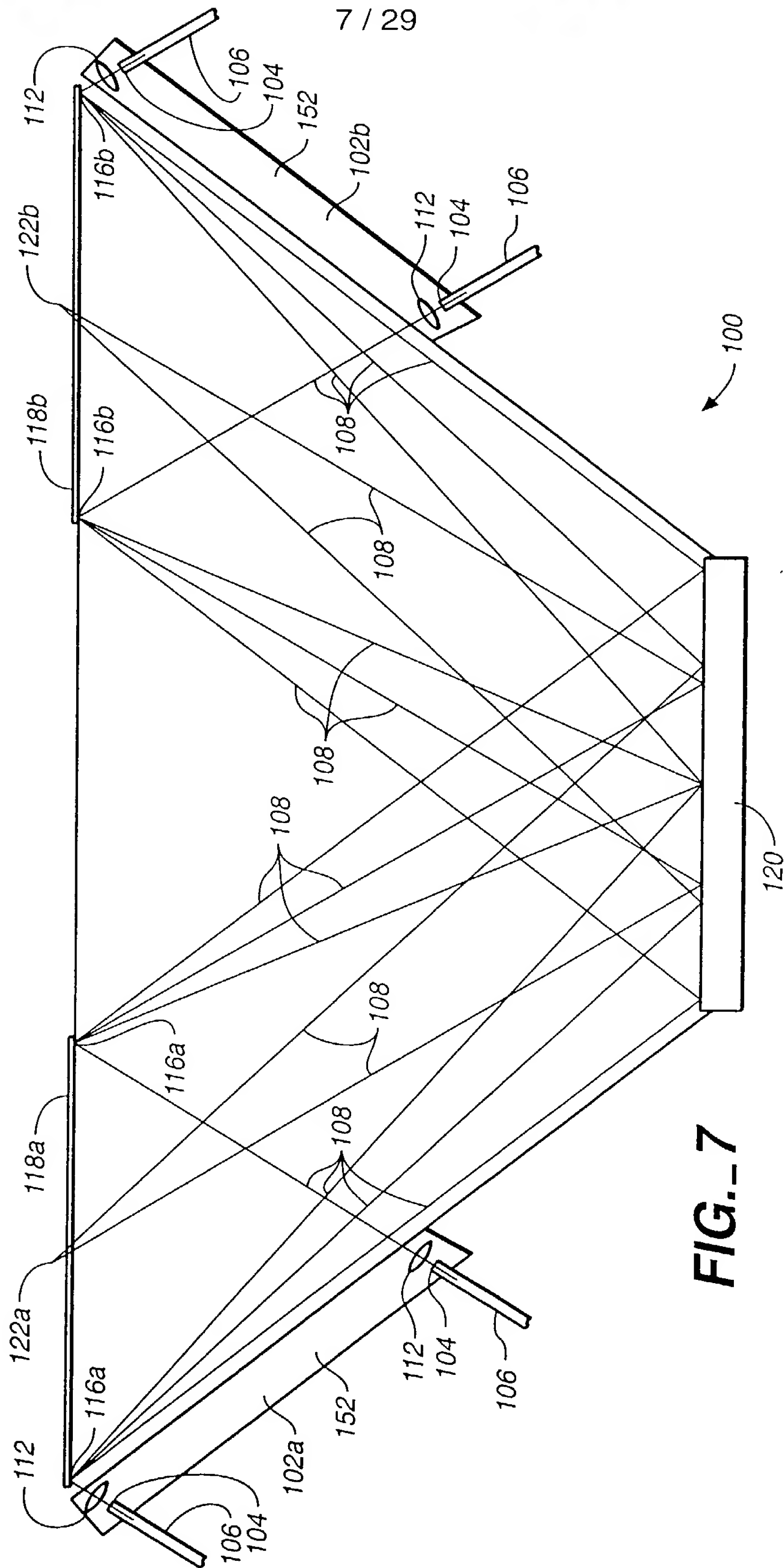
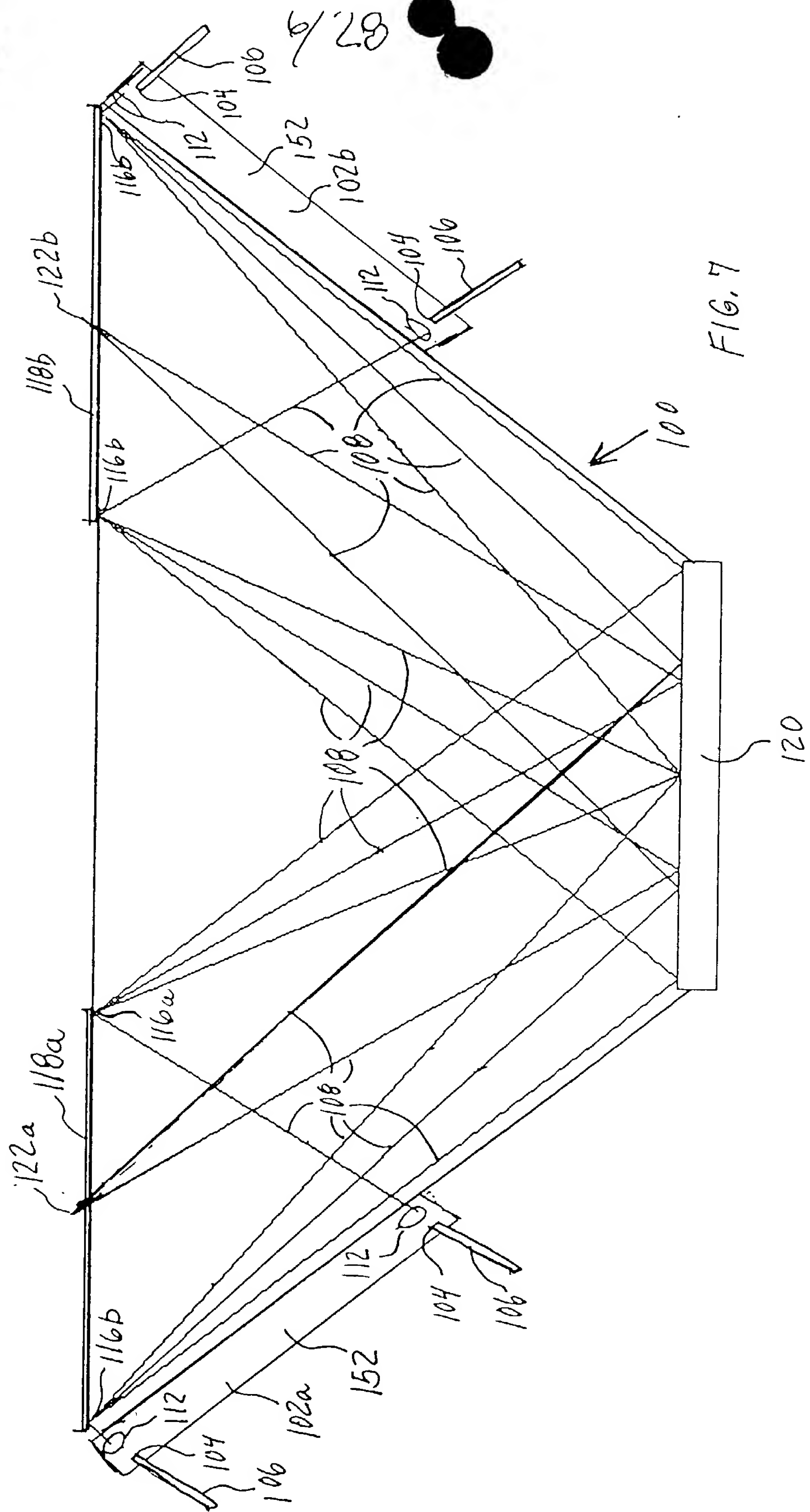


FIG. 7

[illegible]

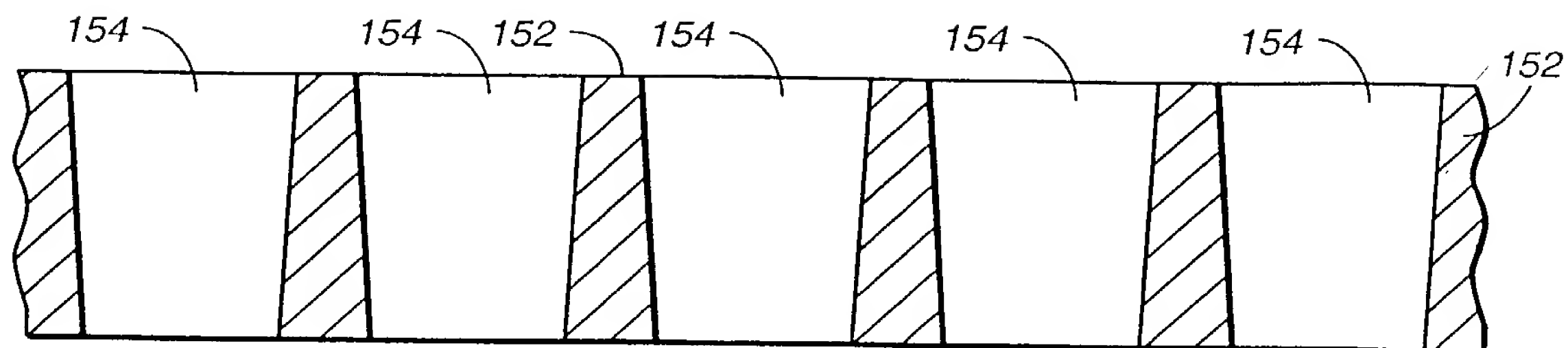


FIG. 10

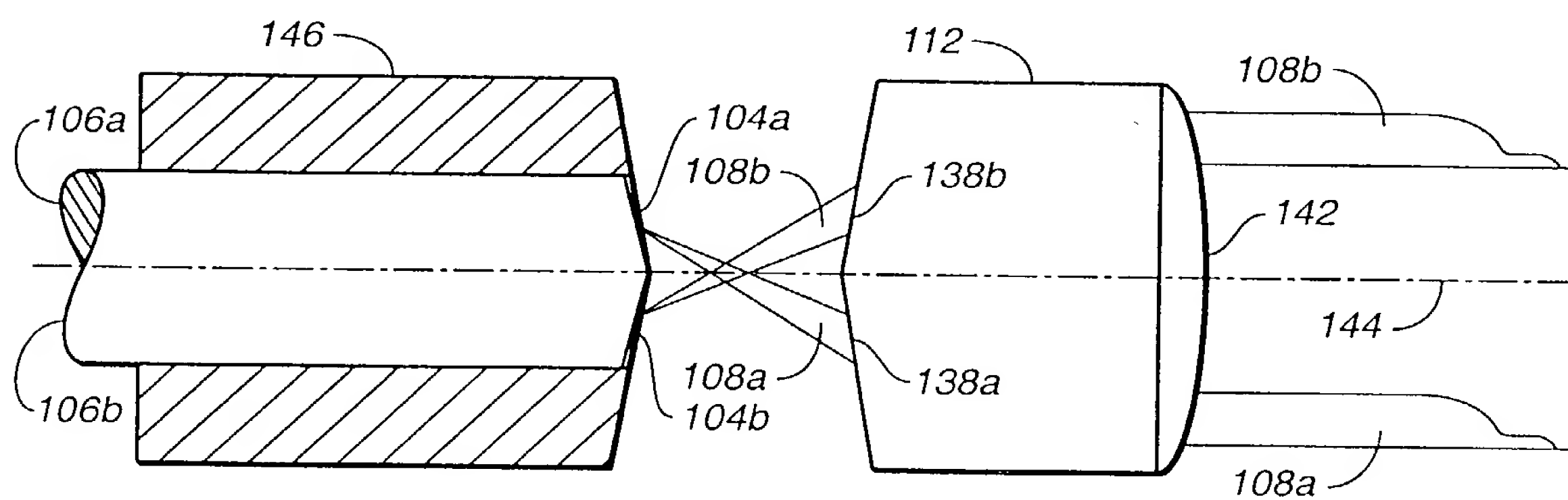


FIG. 11

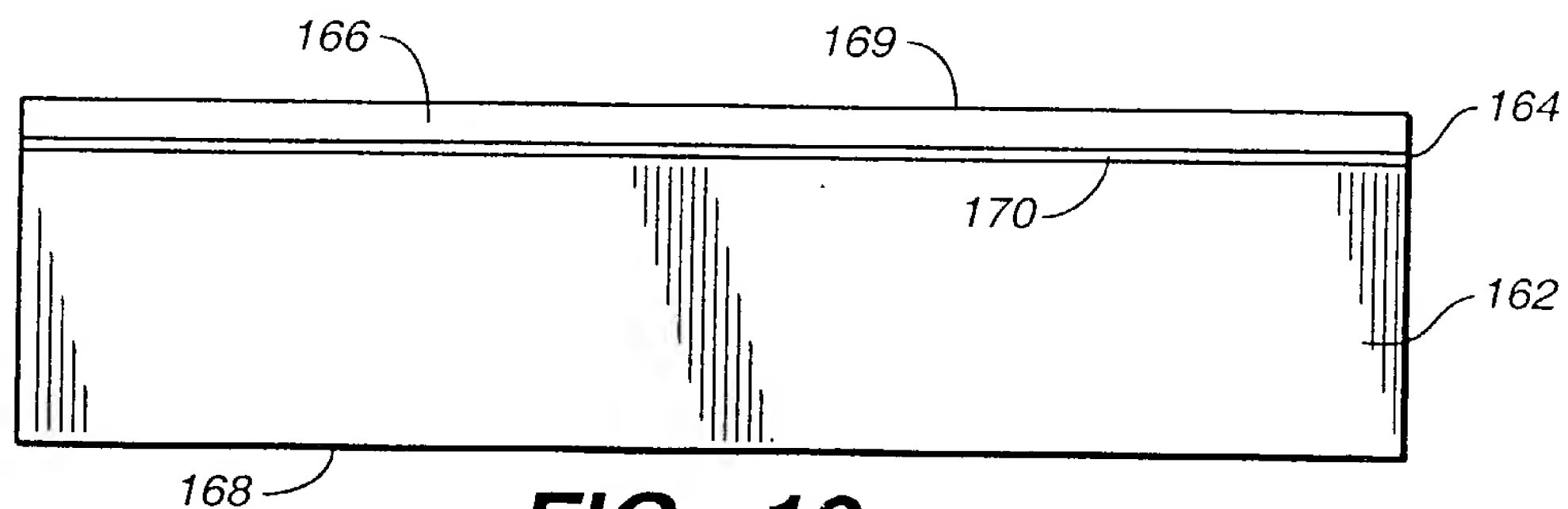


FIG._12

[illegible]

7/28

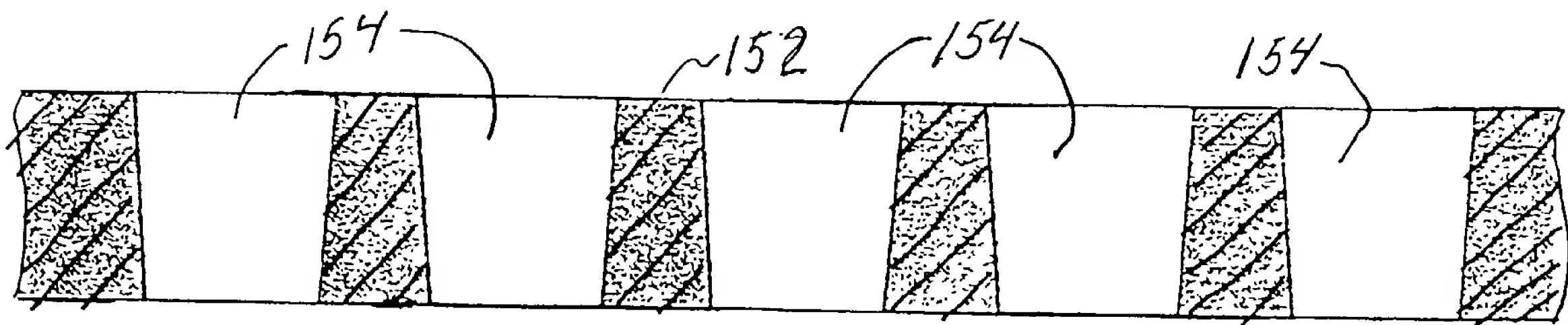
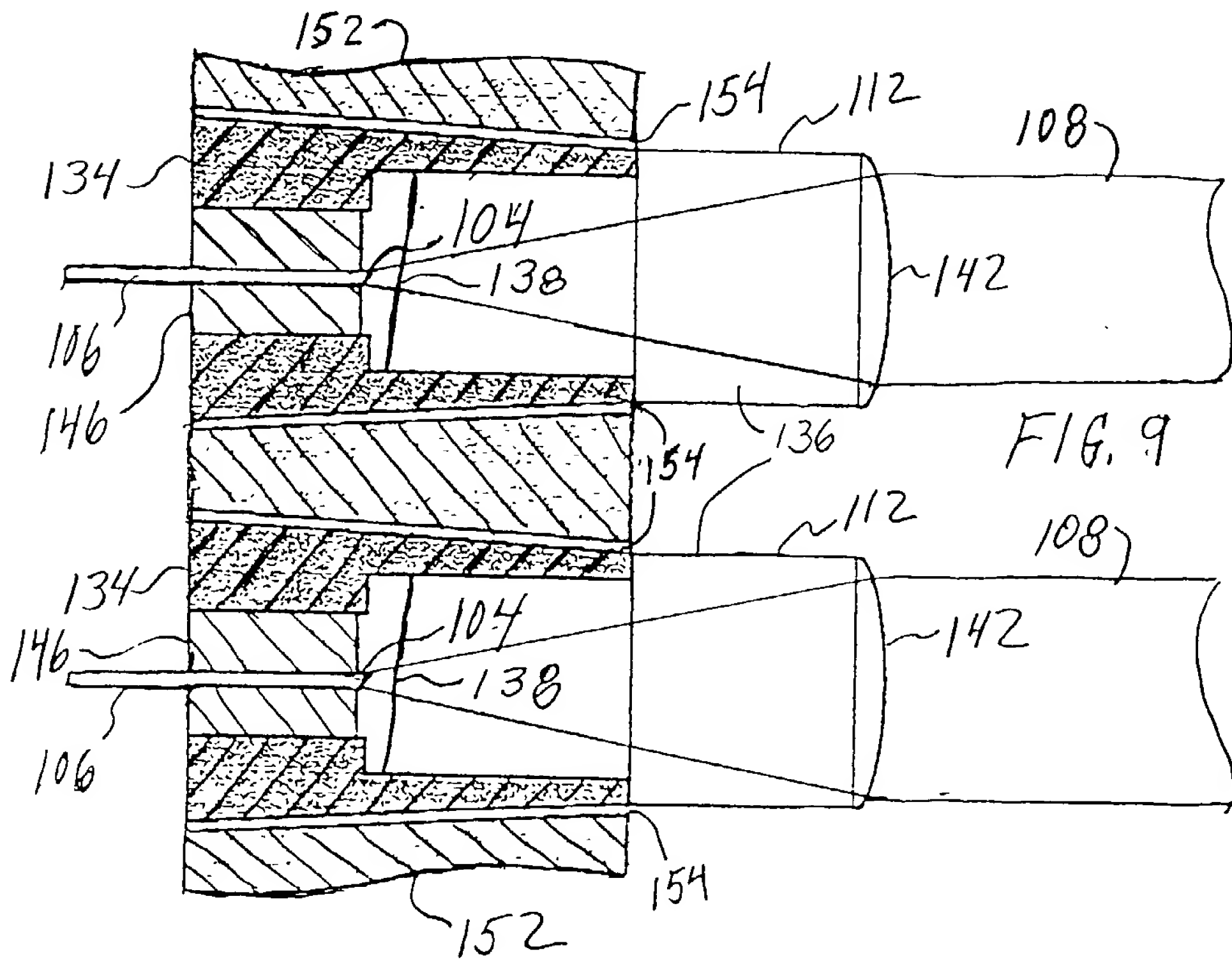
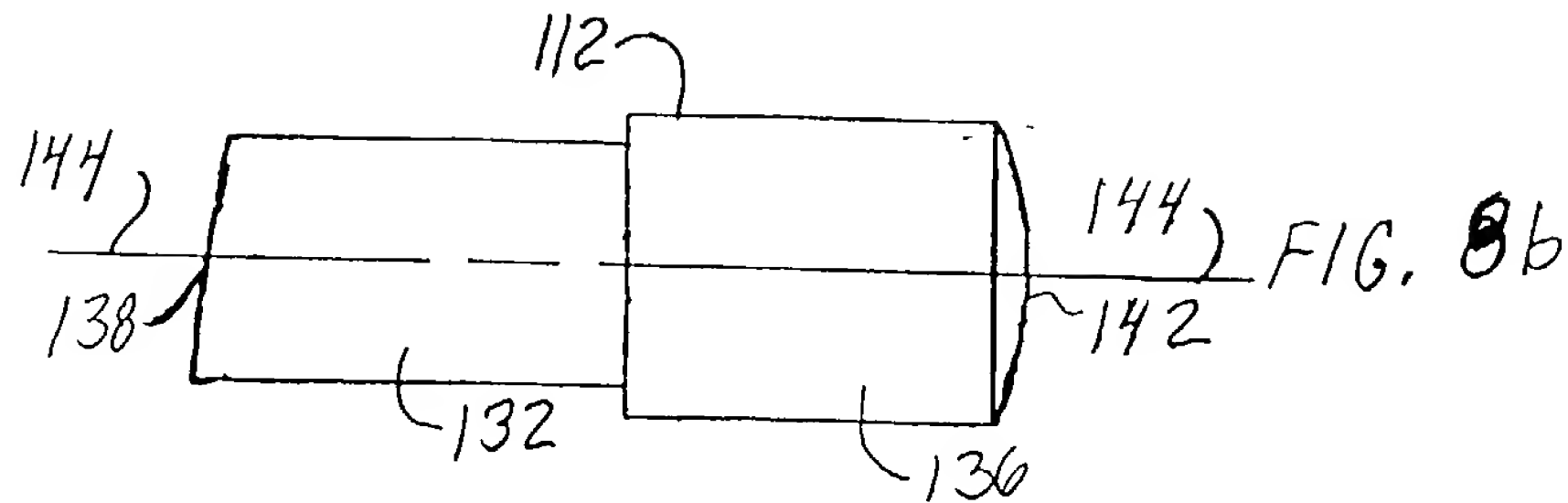


FIG. 10

FIG. 14

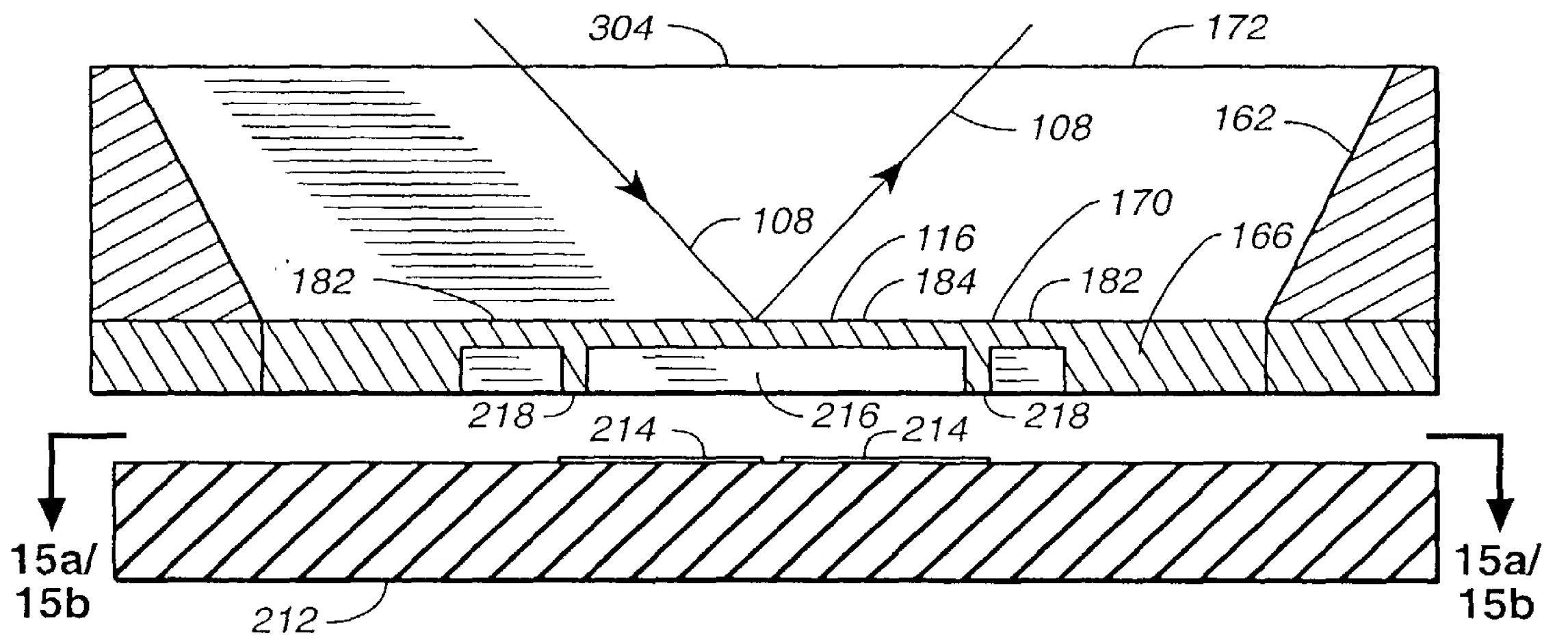
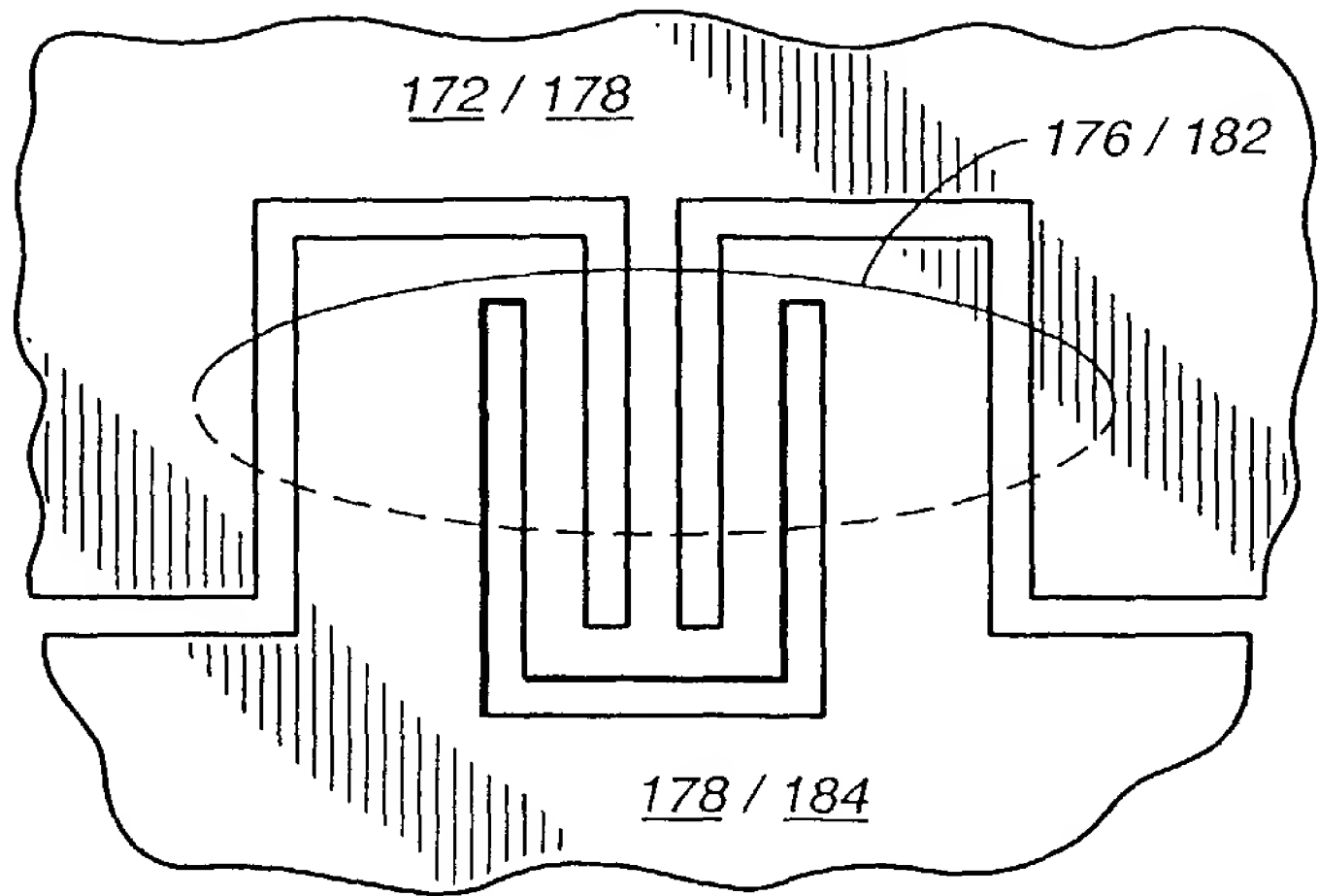


FIG. 15

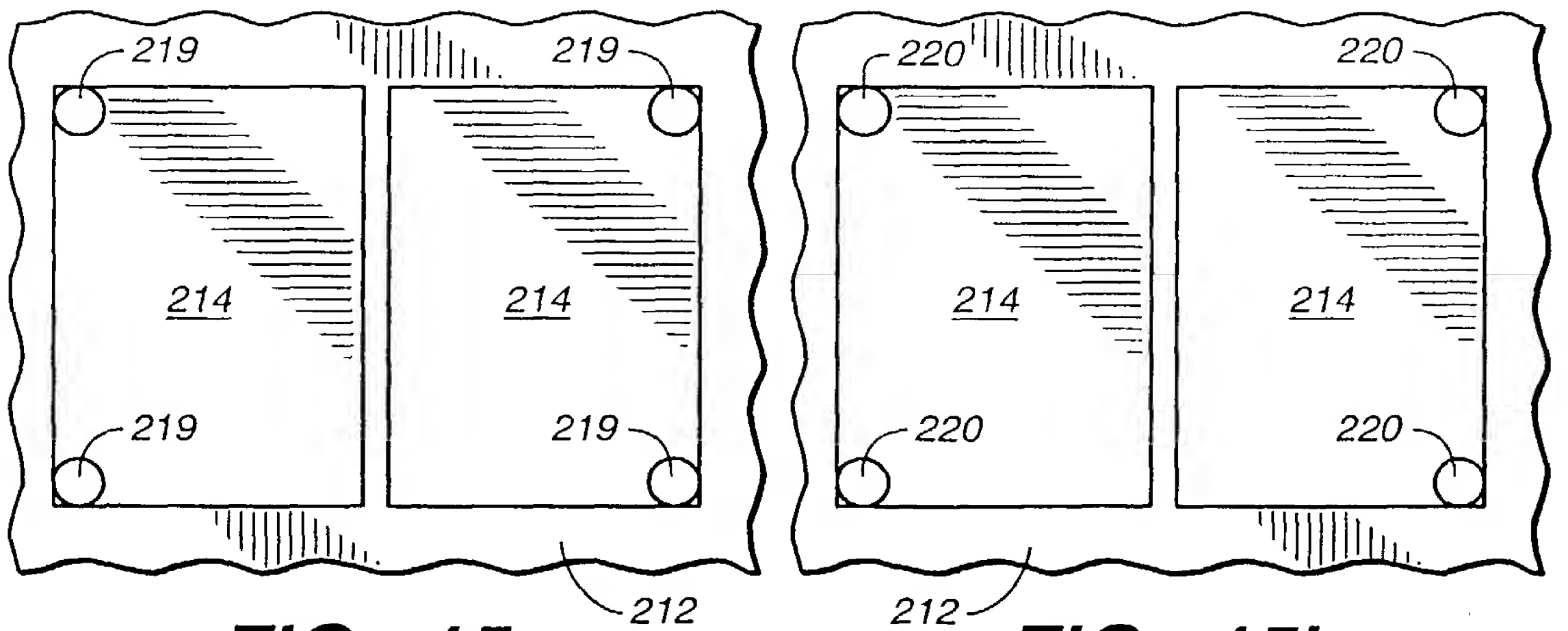
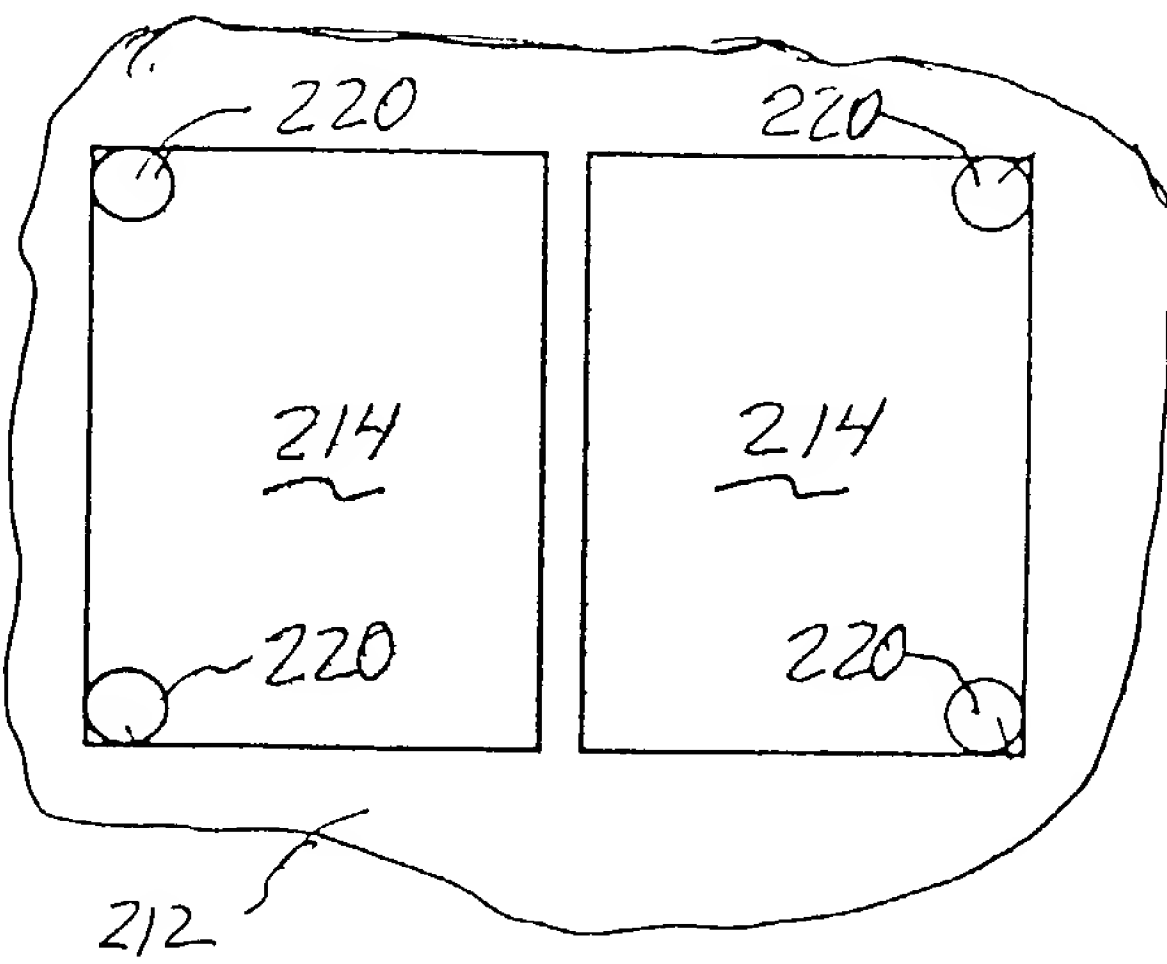
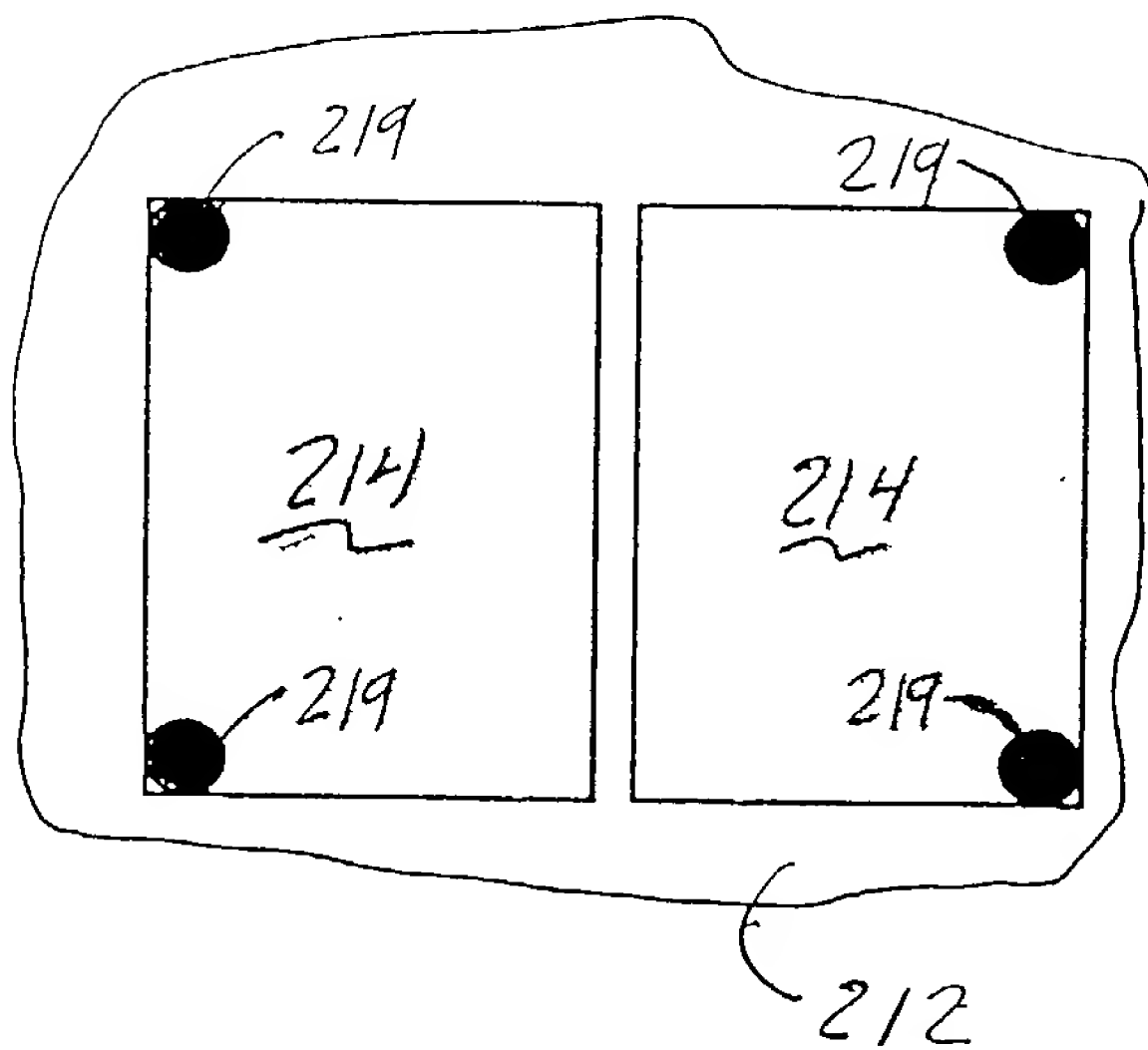
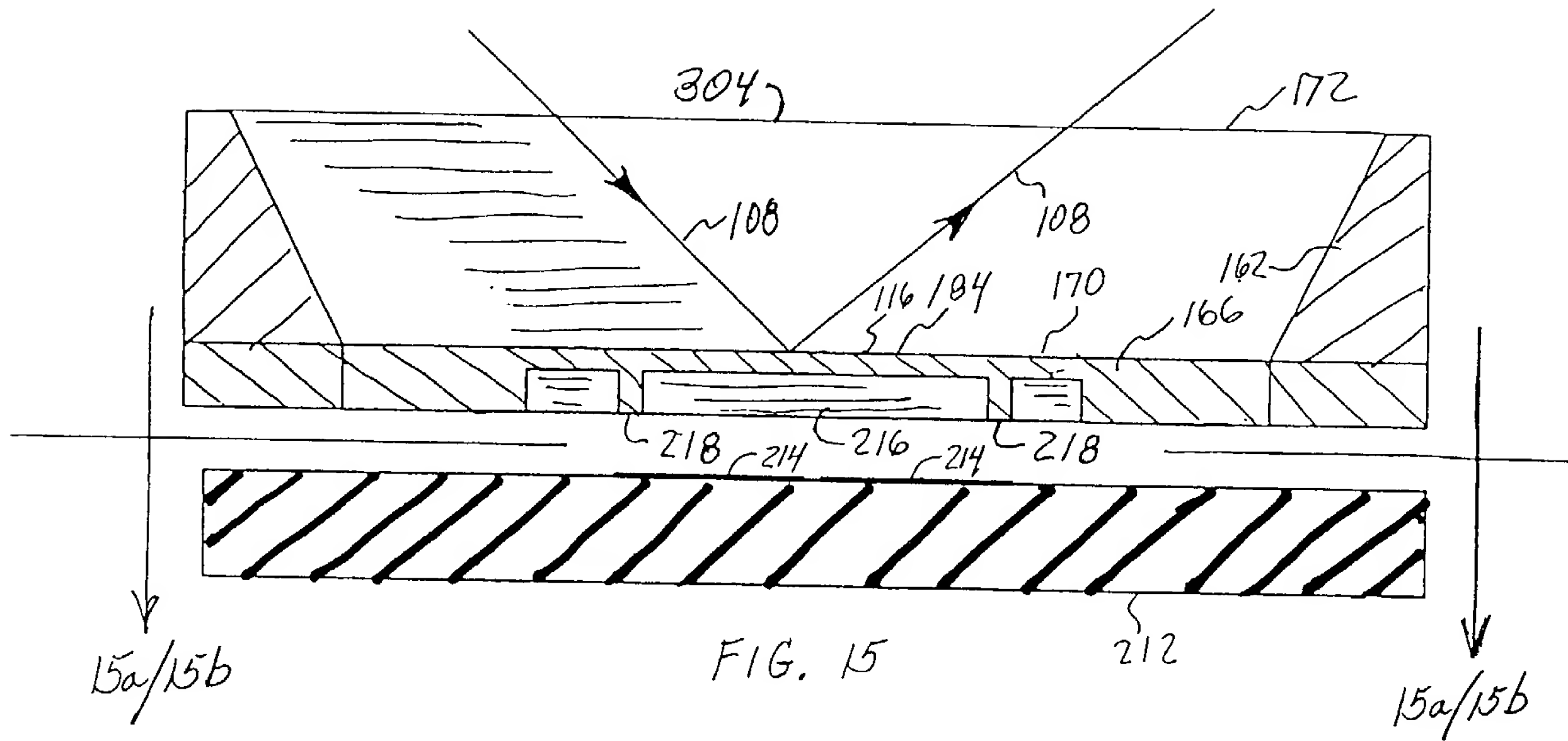
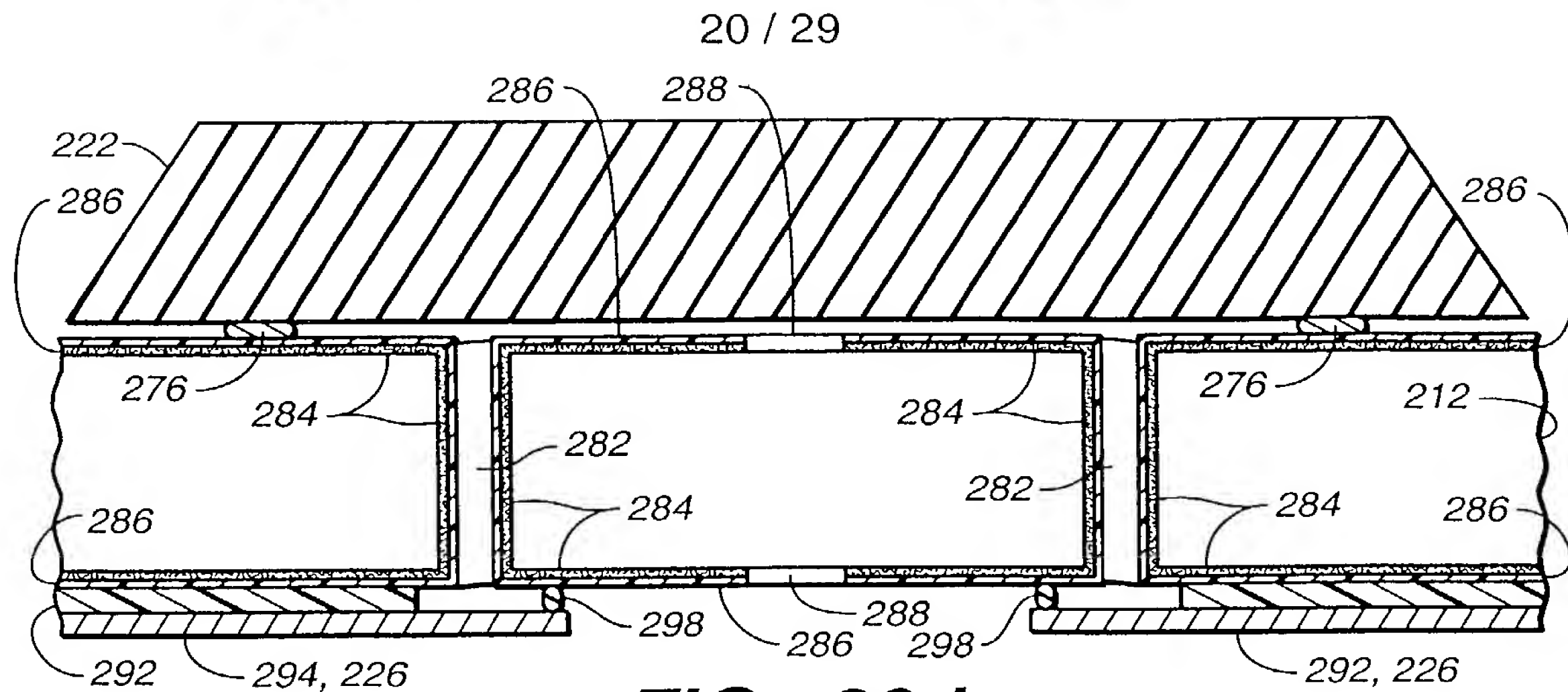
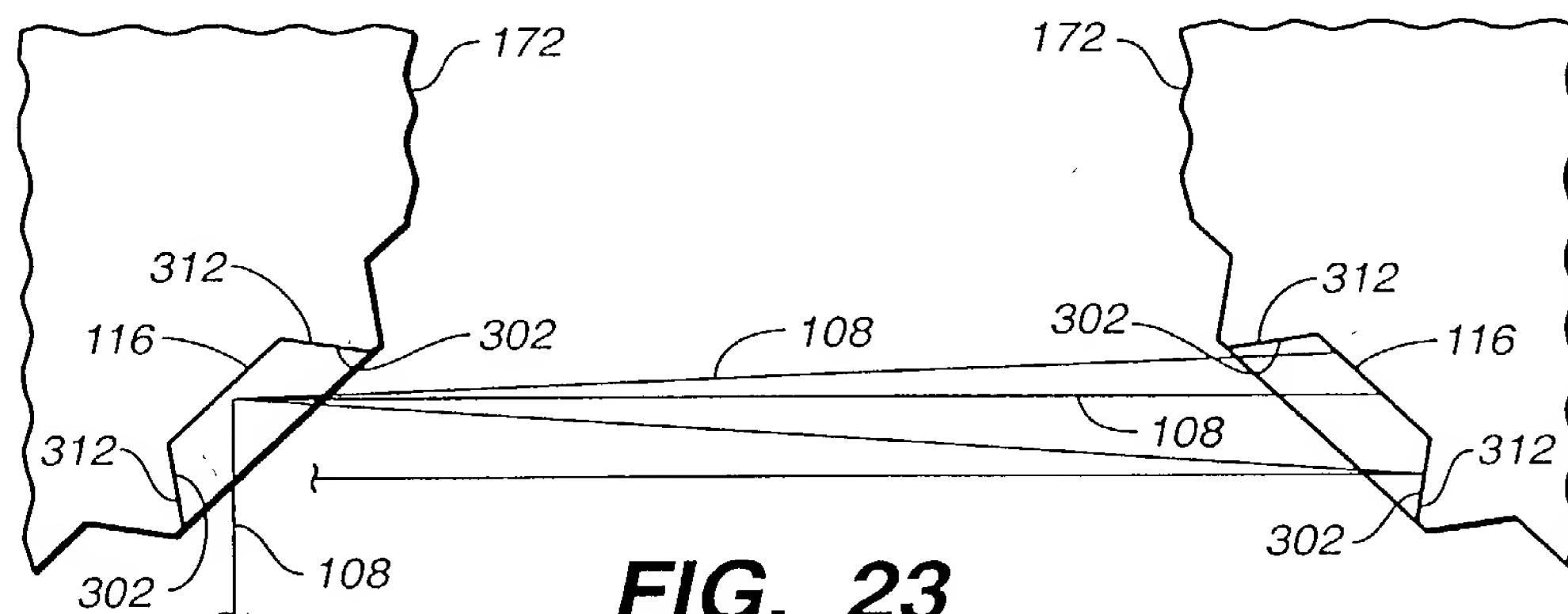
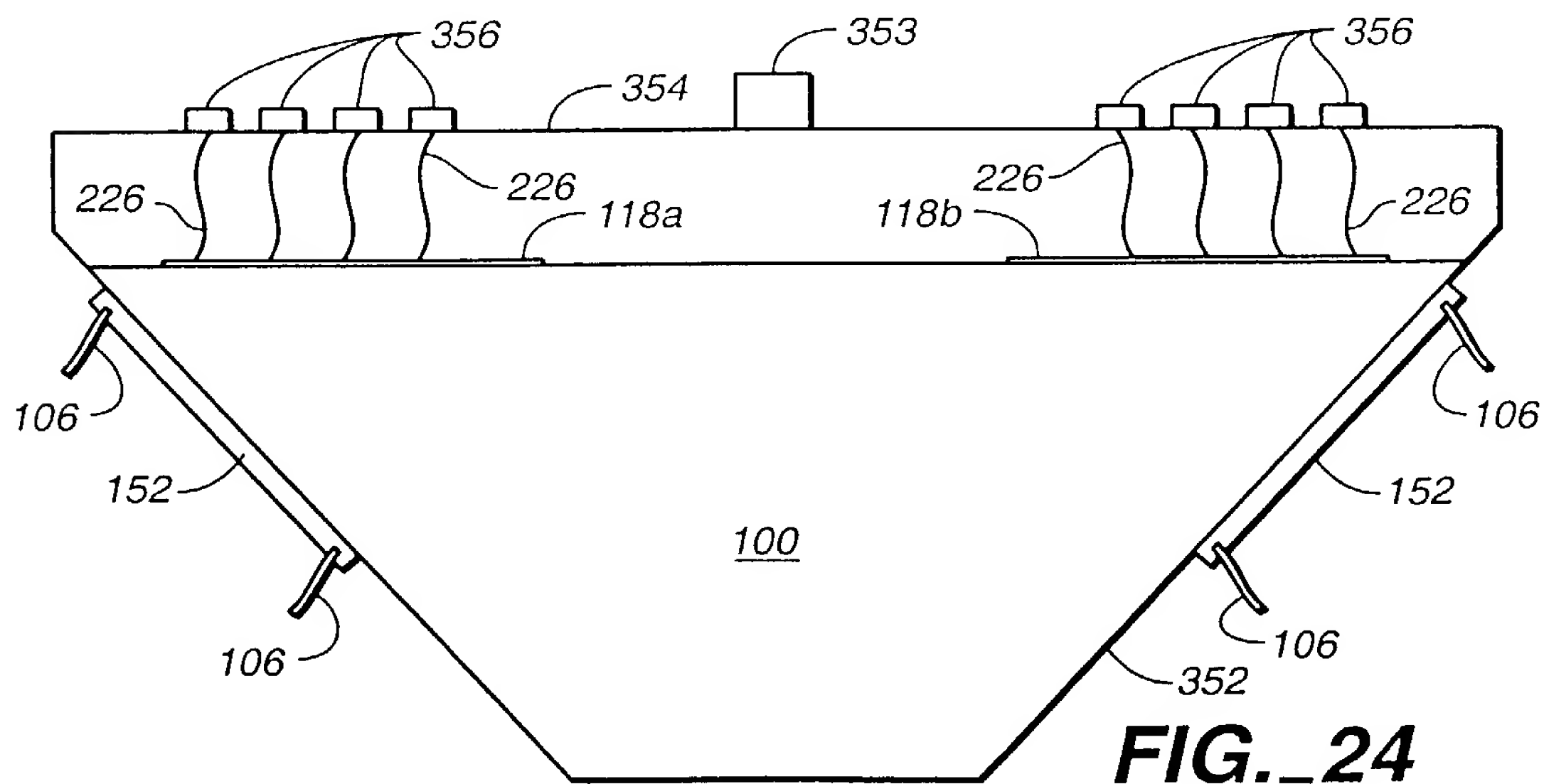


FIG. 15a

FIG. 15b

10/28



**FIG. 22d****FIG. 23****FIG. 24**

19/28

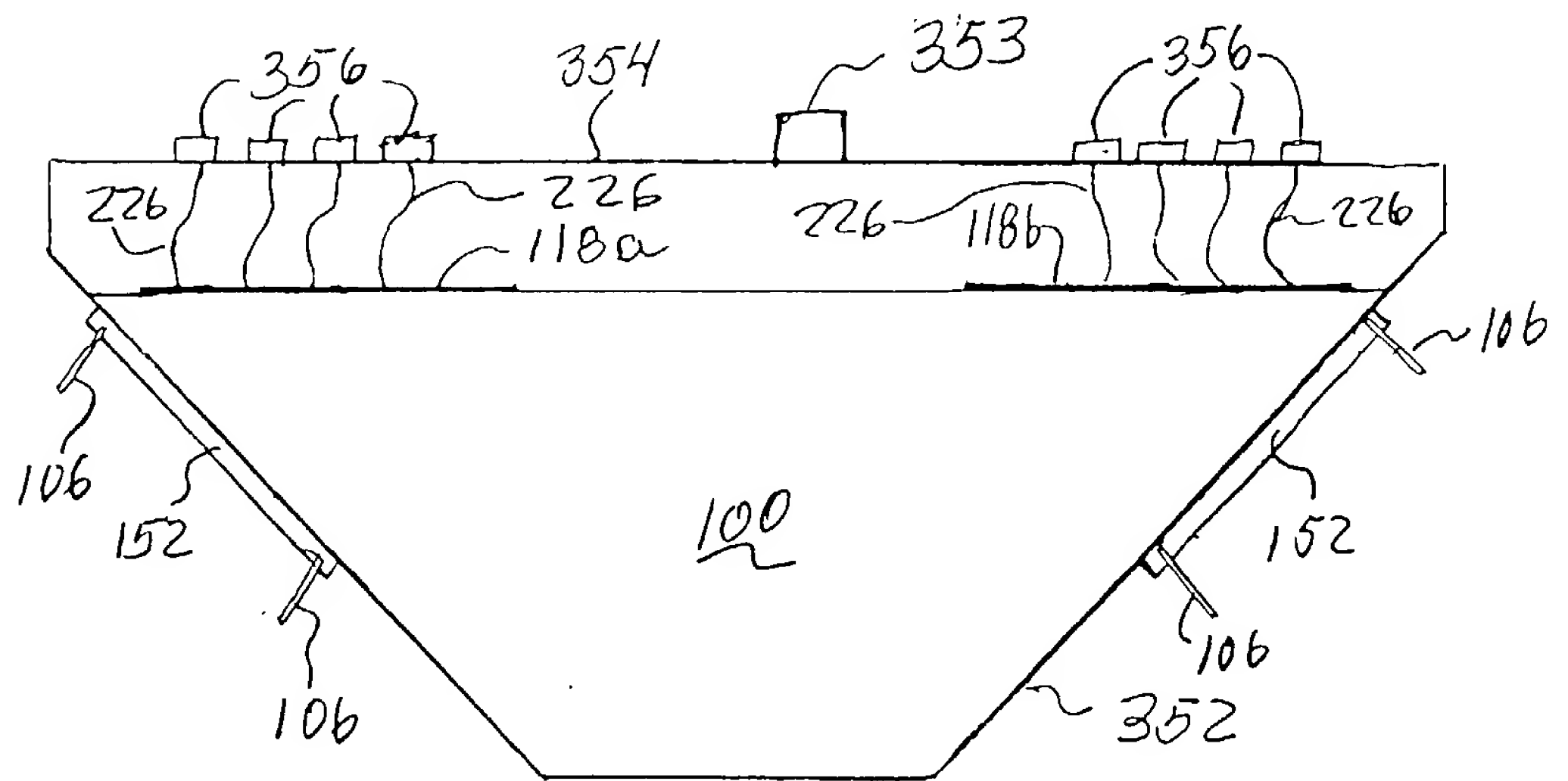
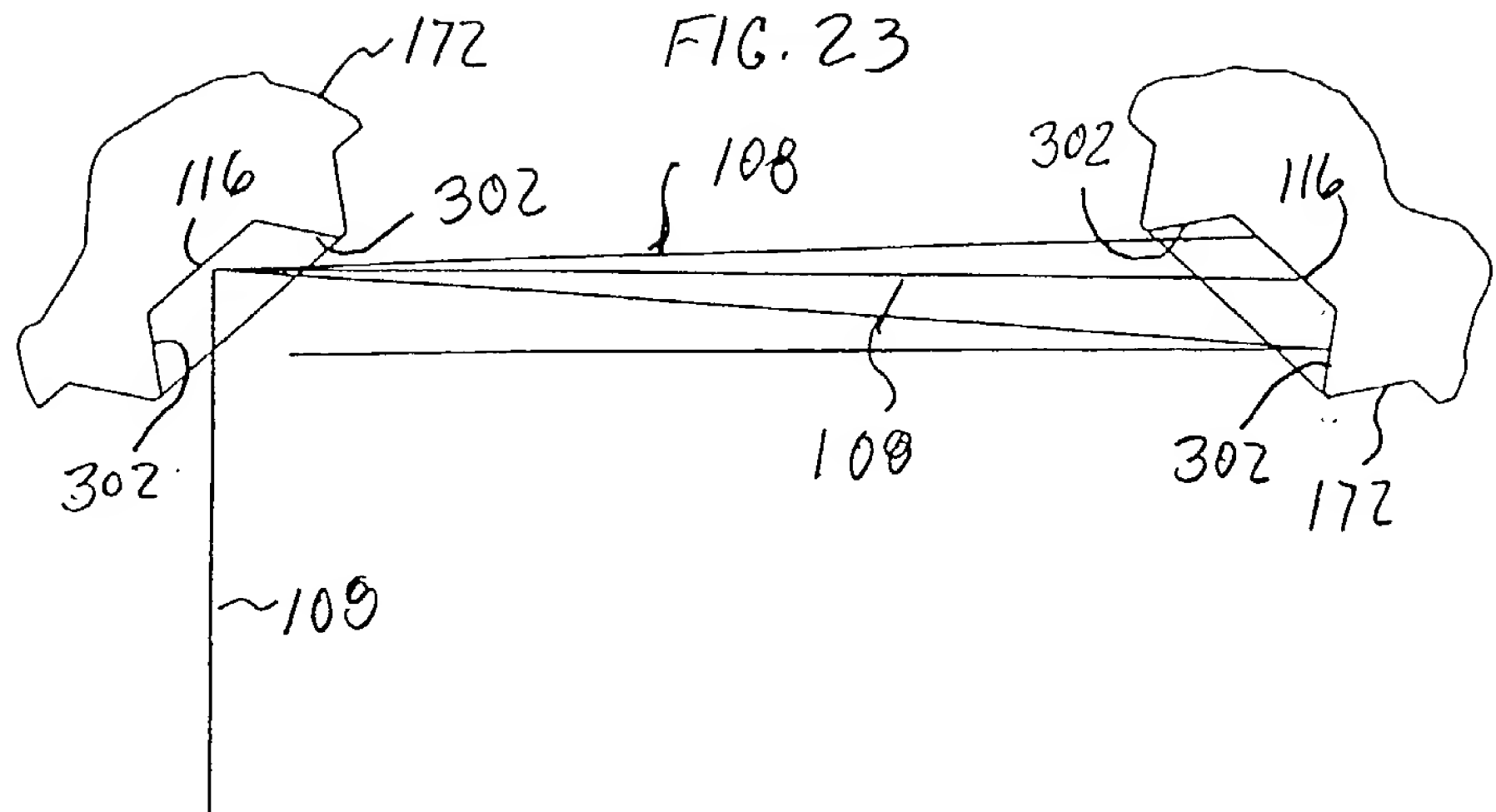


FIG. 24

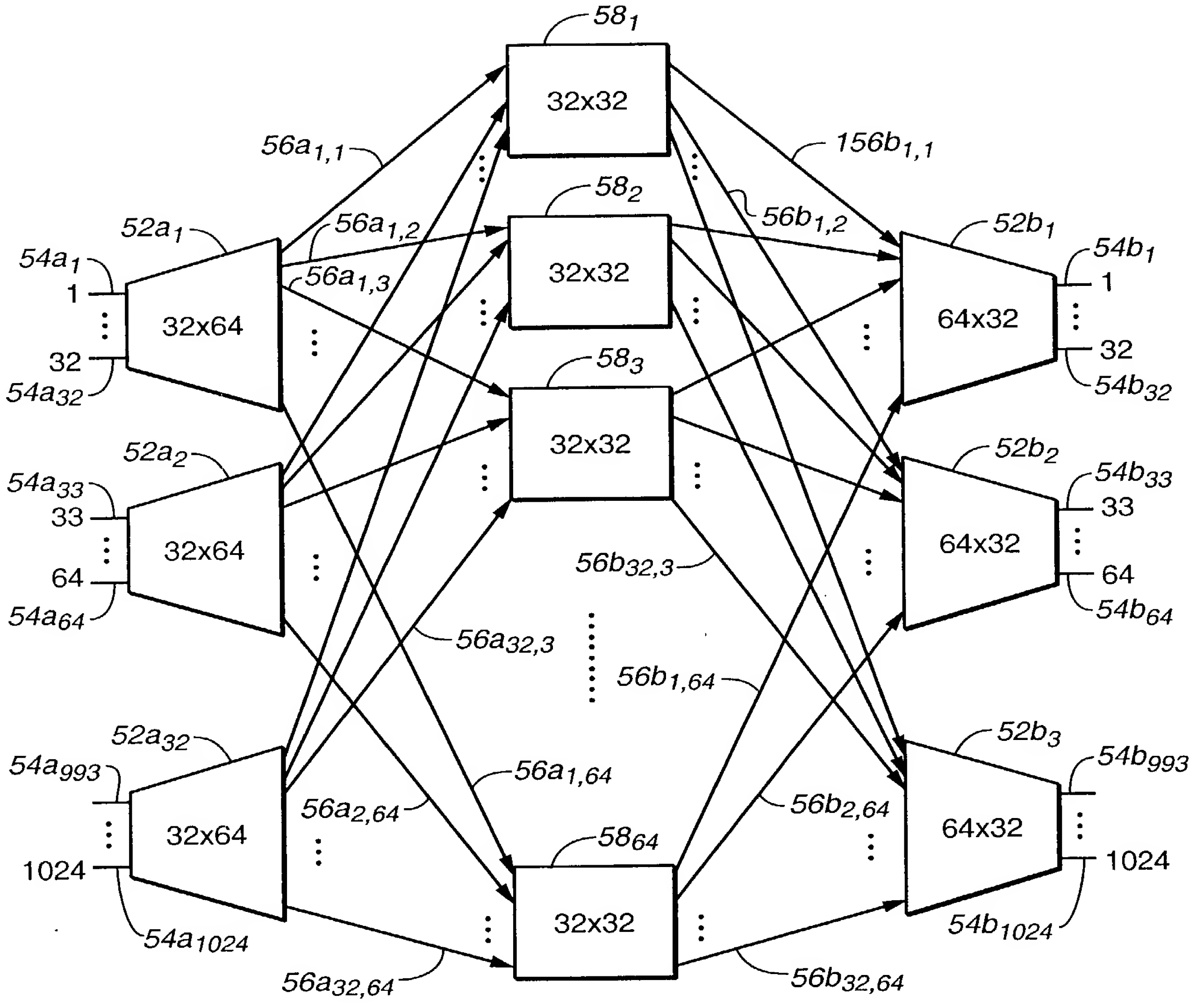


FIG. 1
(PRIOR ART)

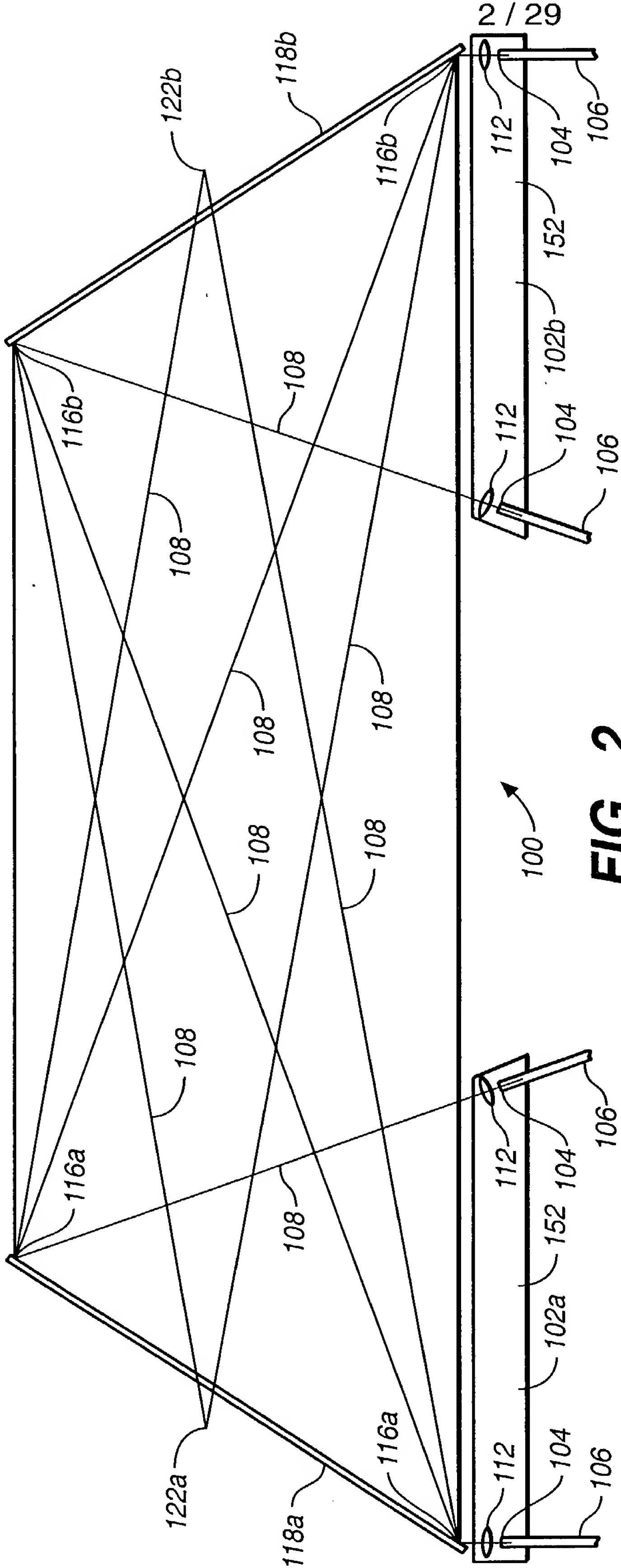


FIG. 2

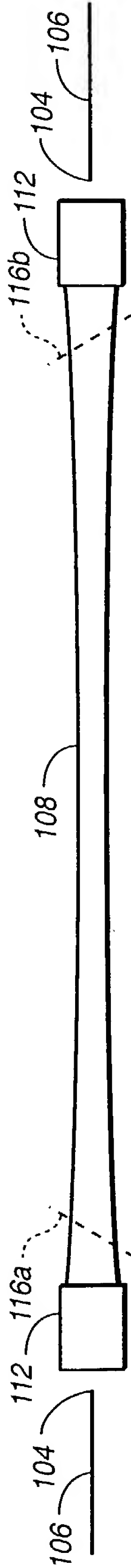


FIG. 3

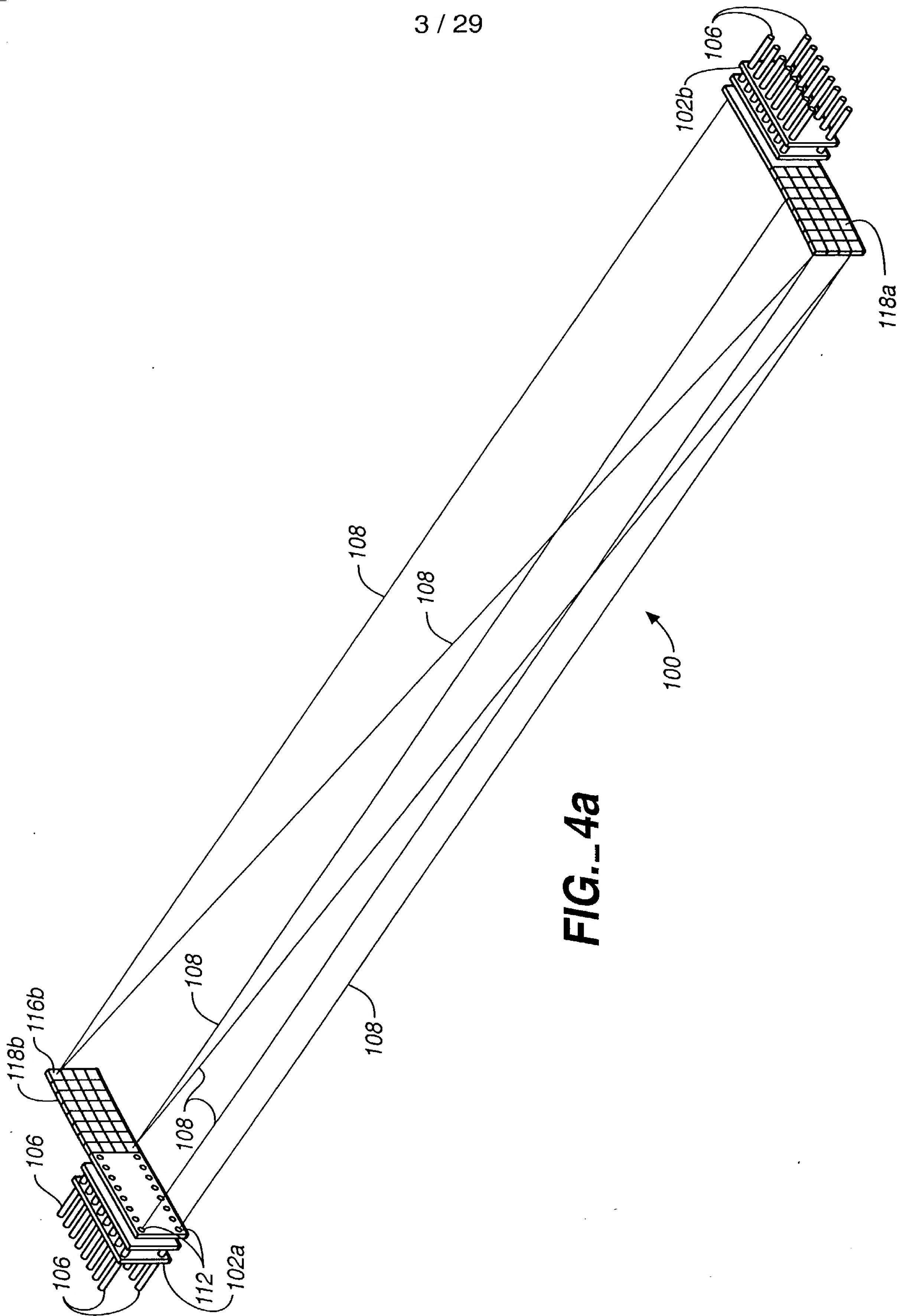
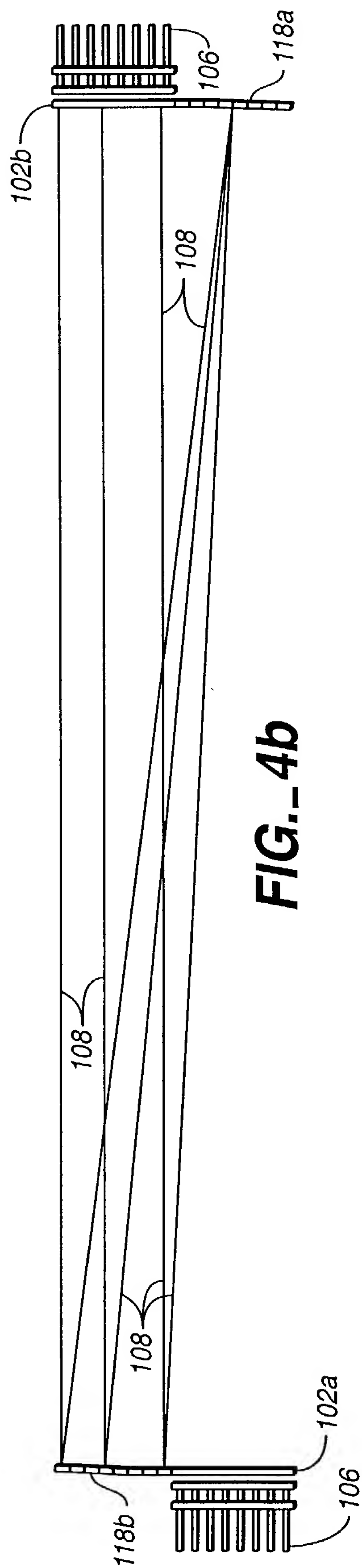


FIG. 4a



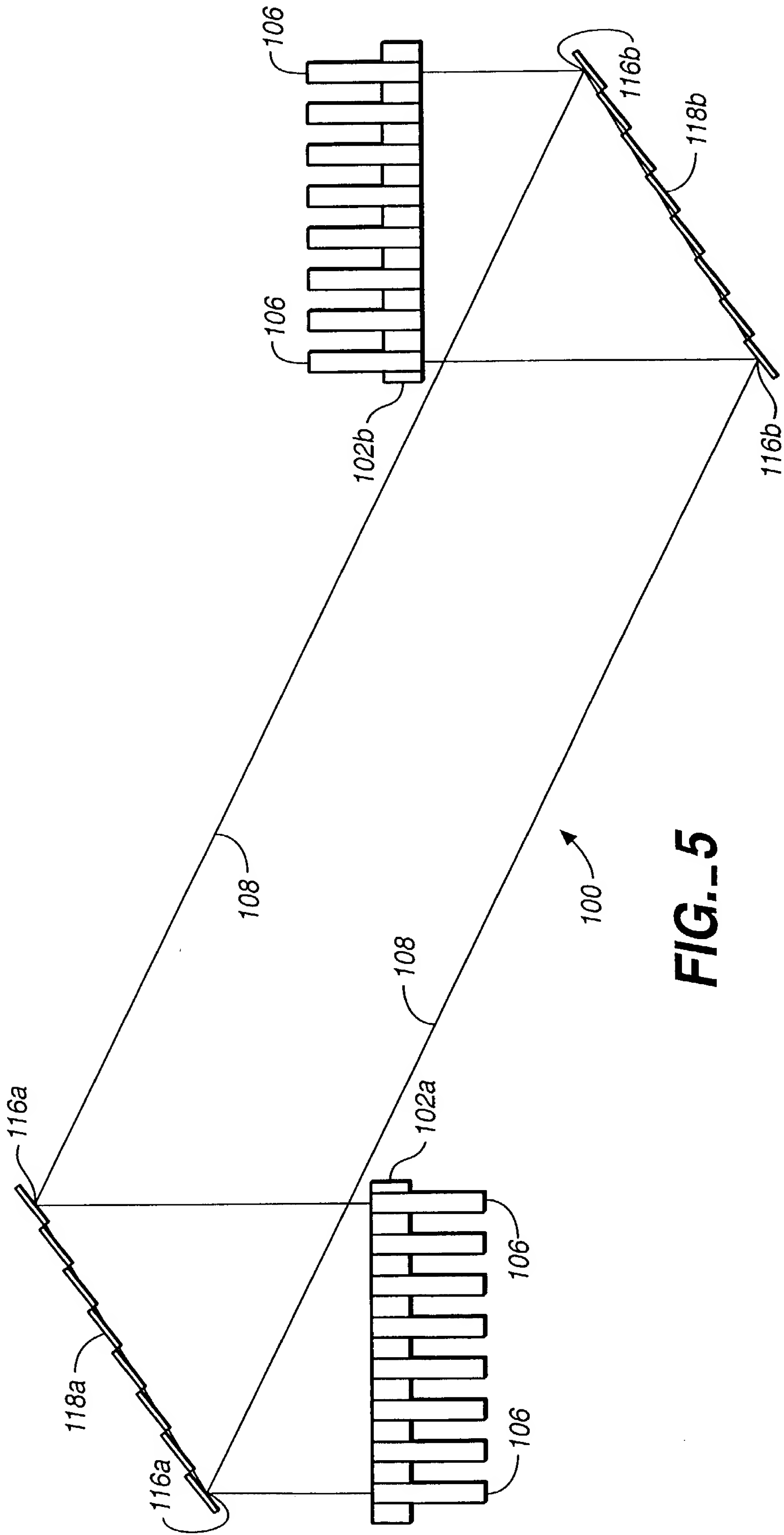
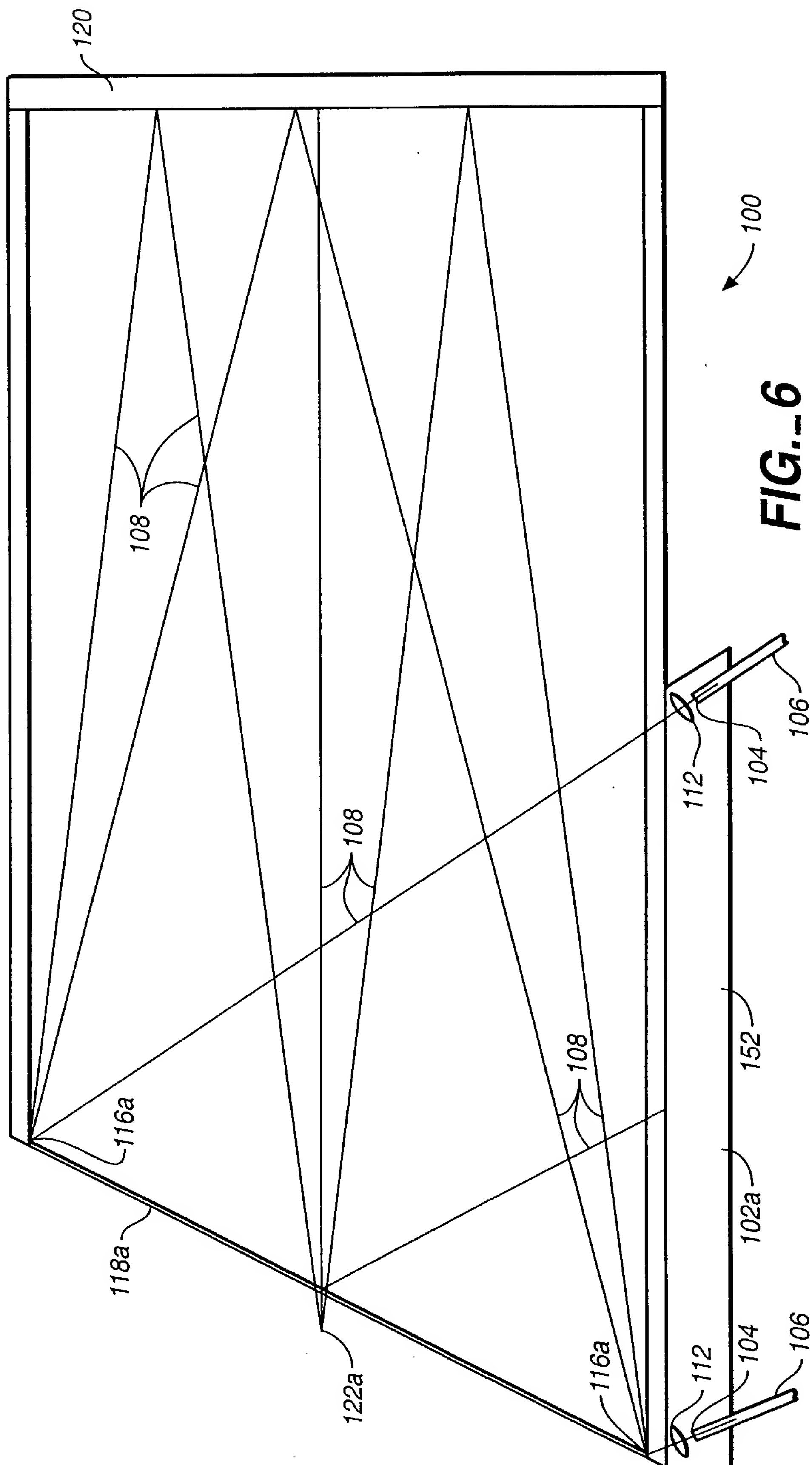
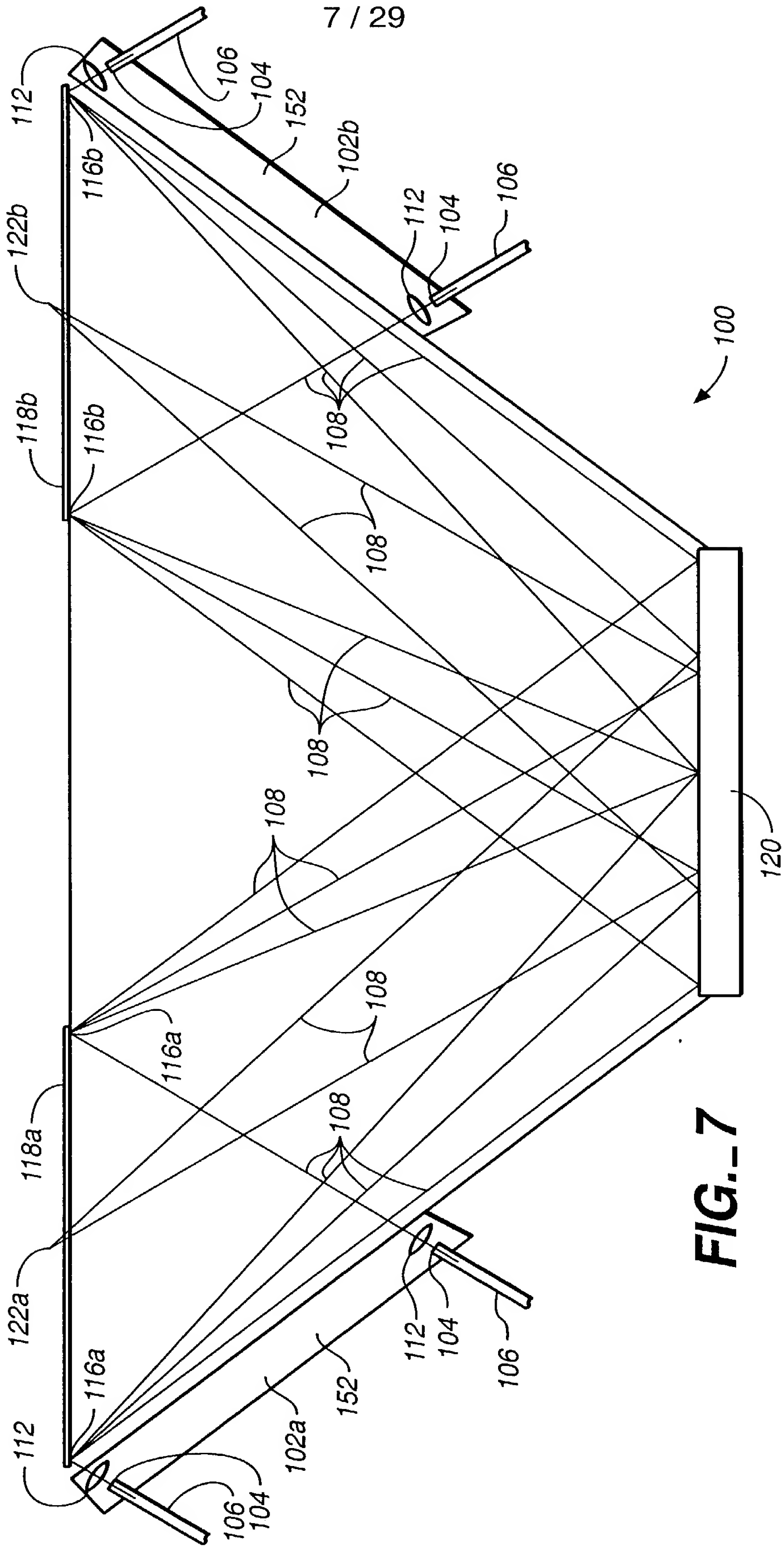
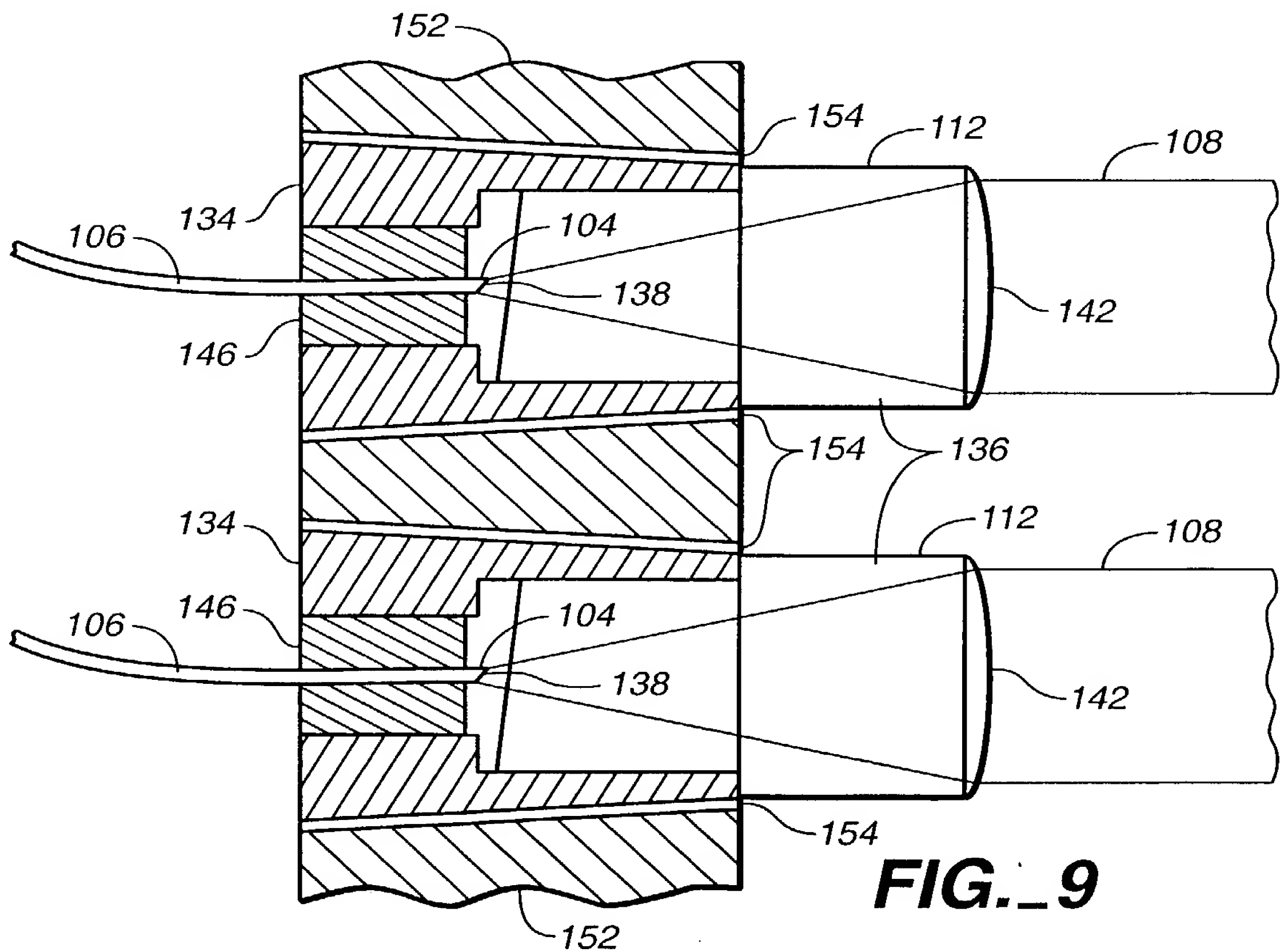
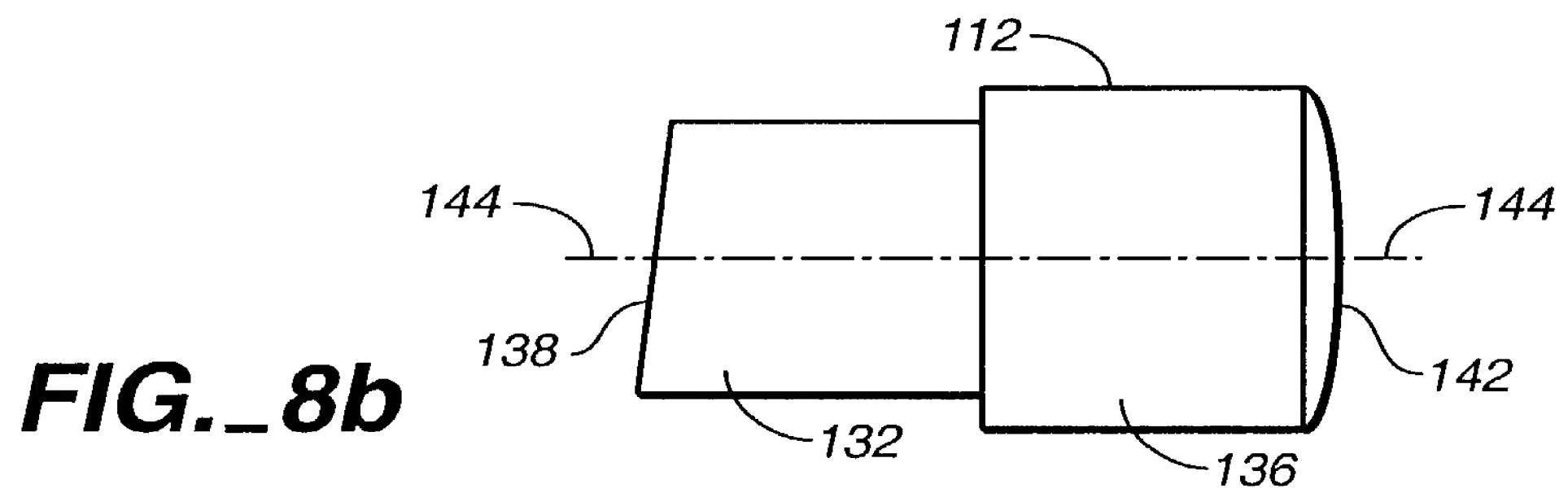
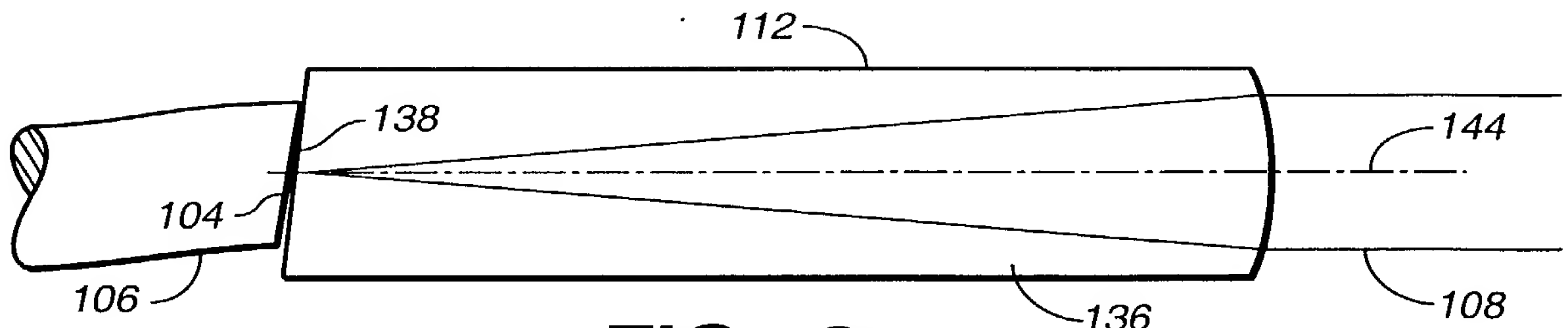


FIG. 5







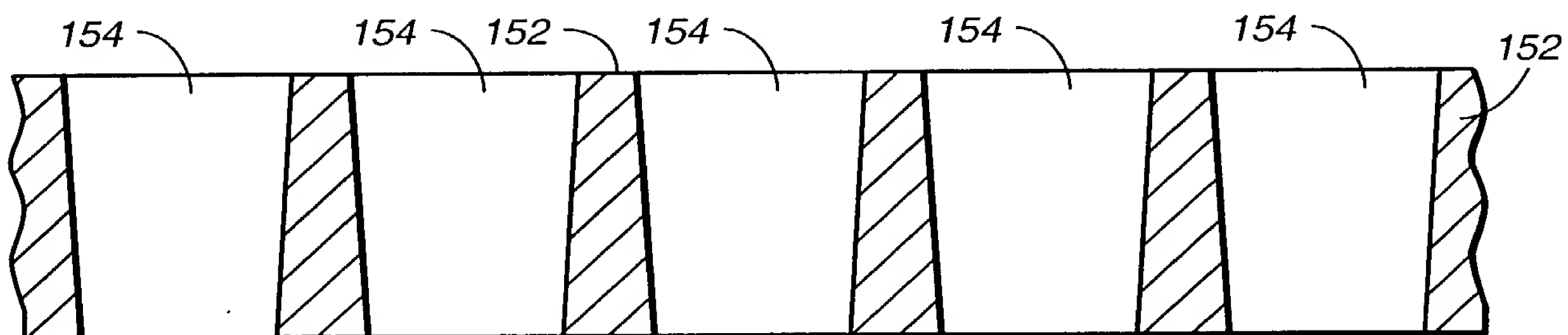
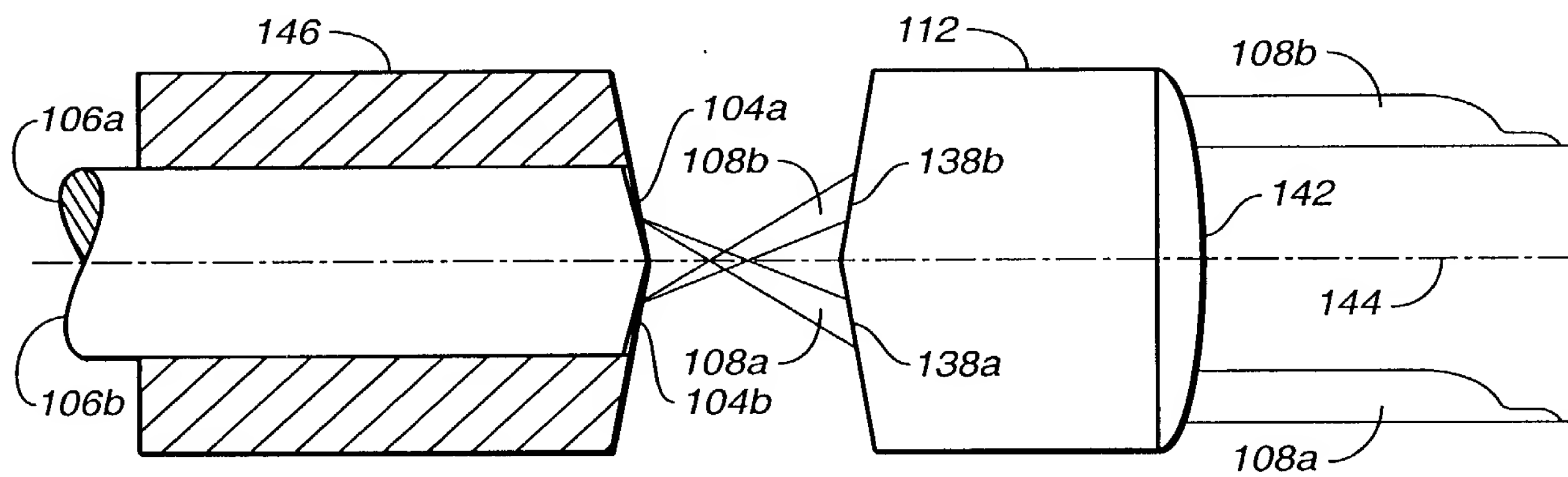
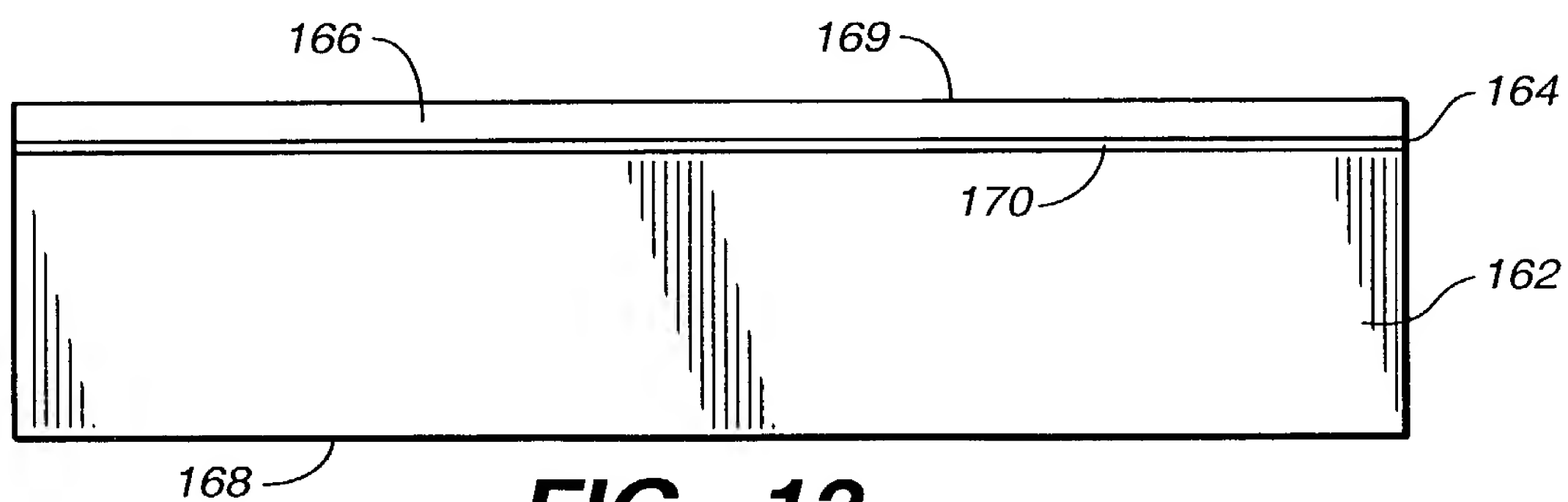
**FIG._10****FIG._11****FIG._12**

FIG. 13

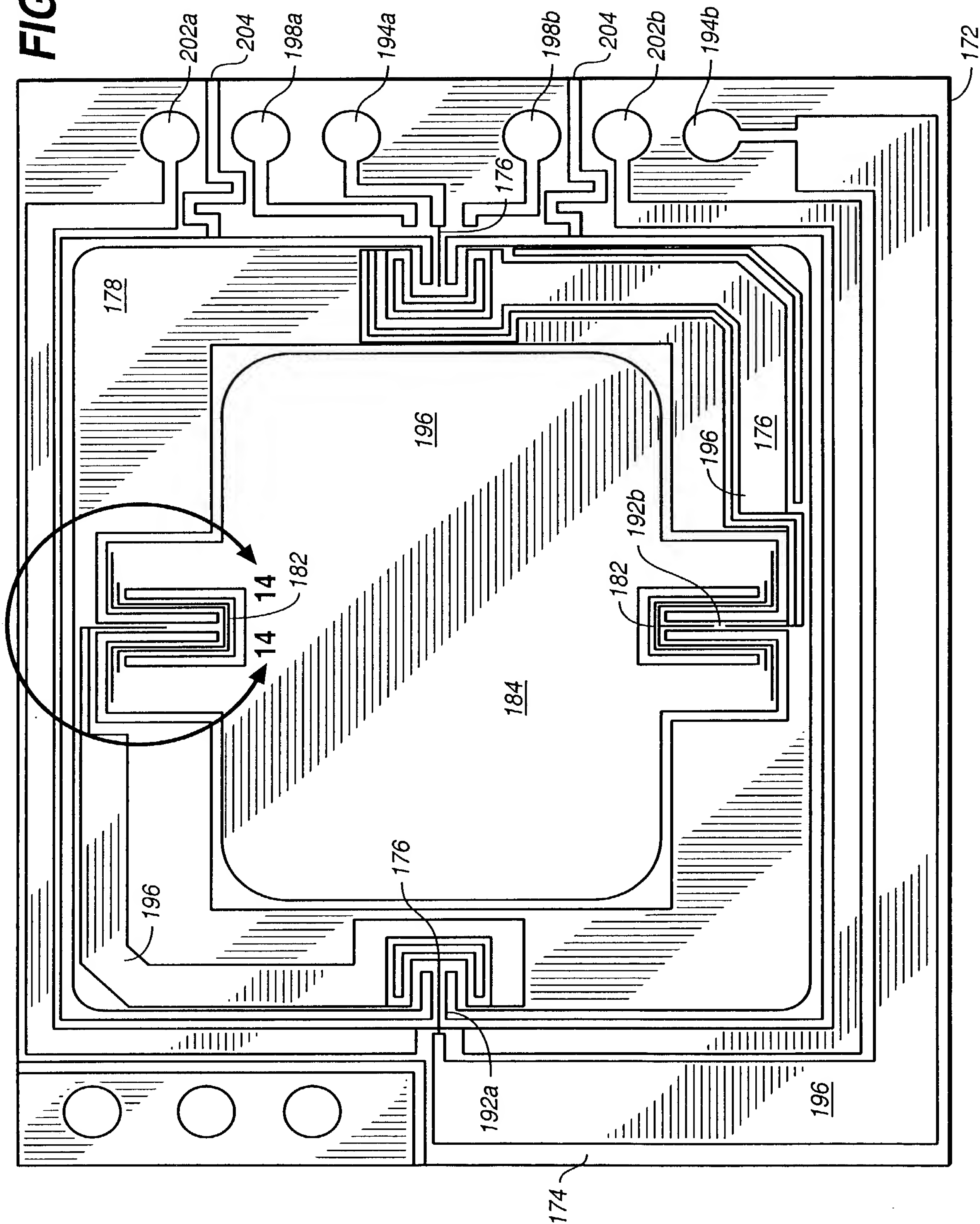
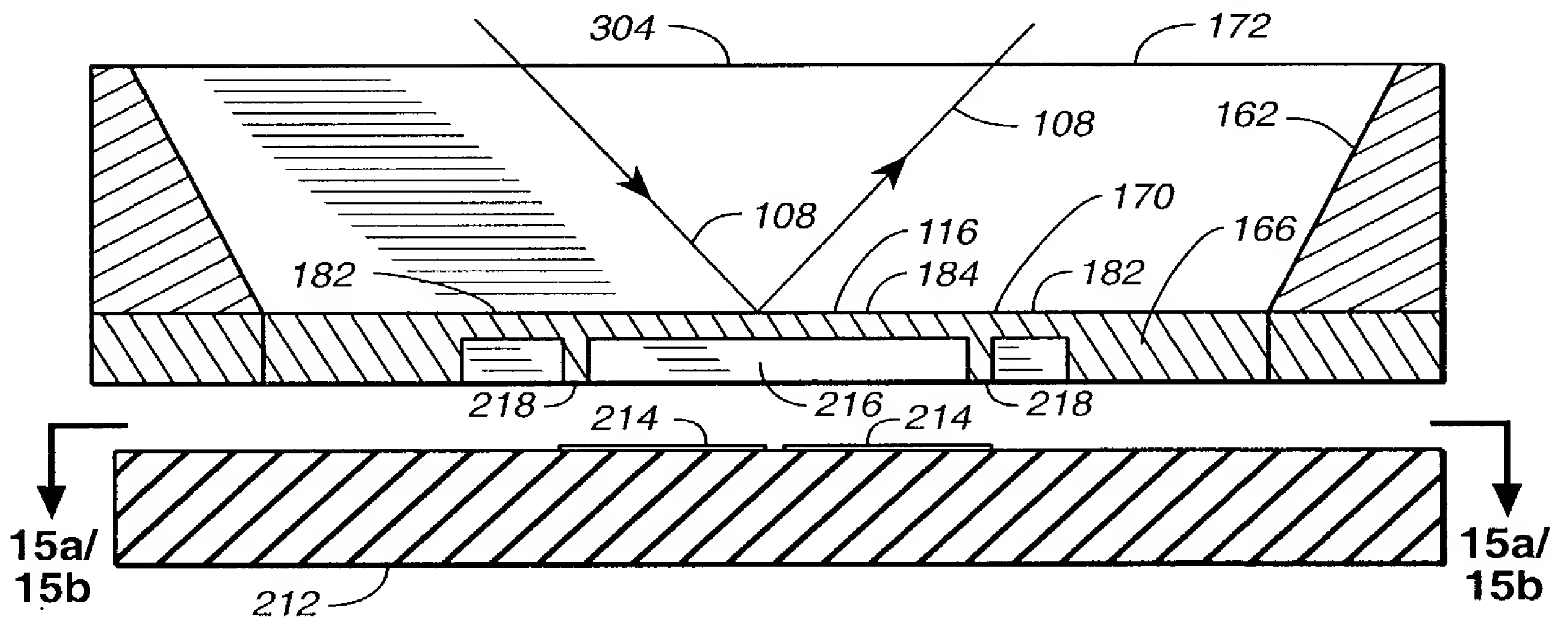
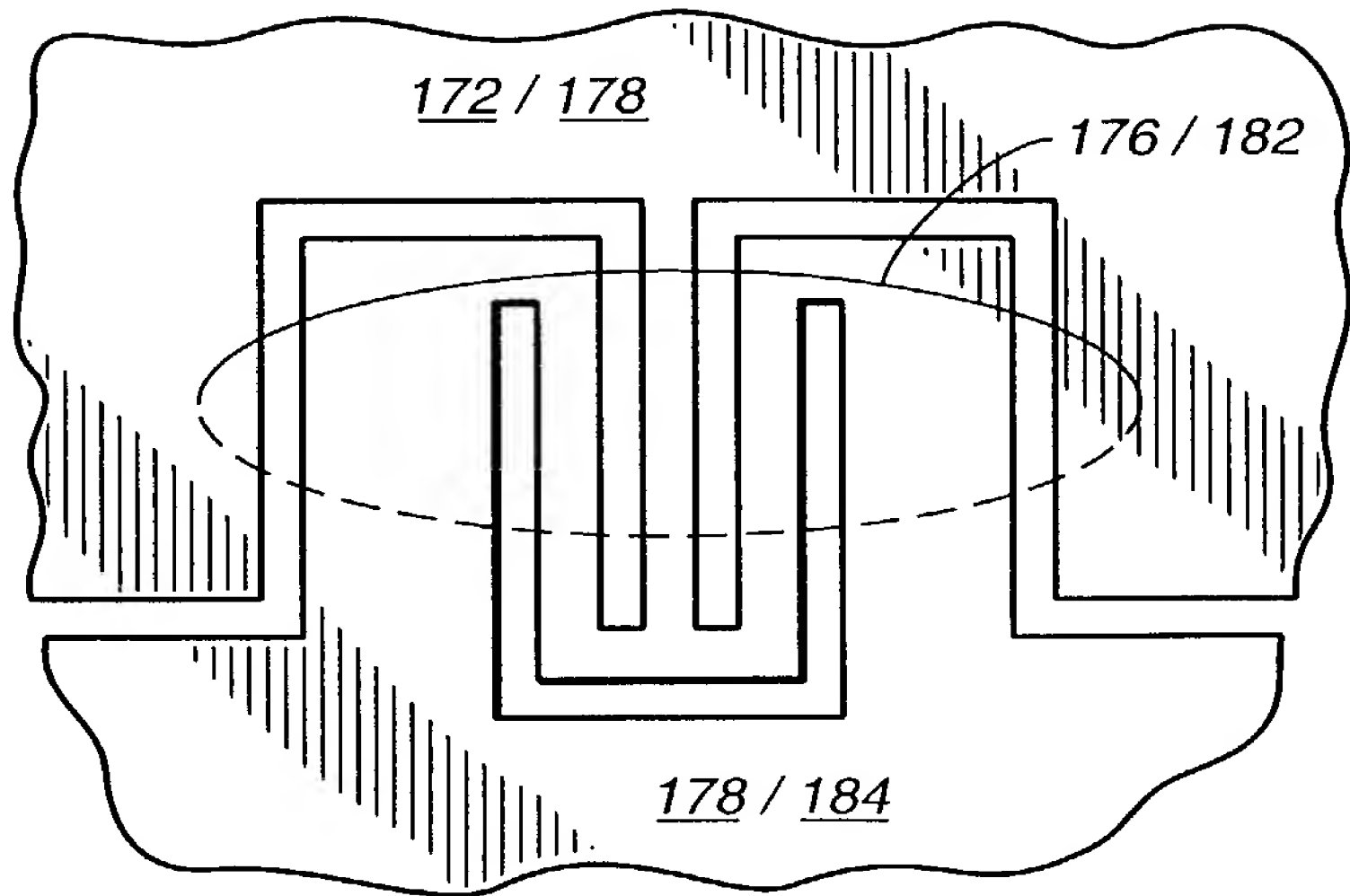
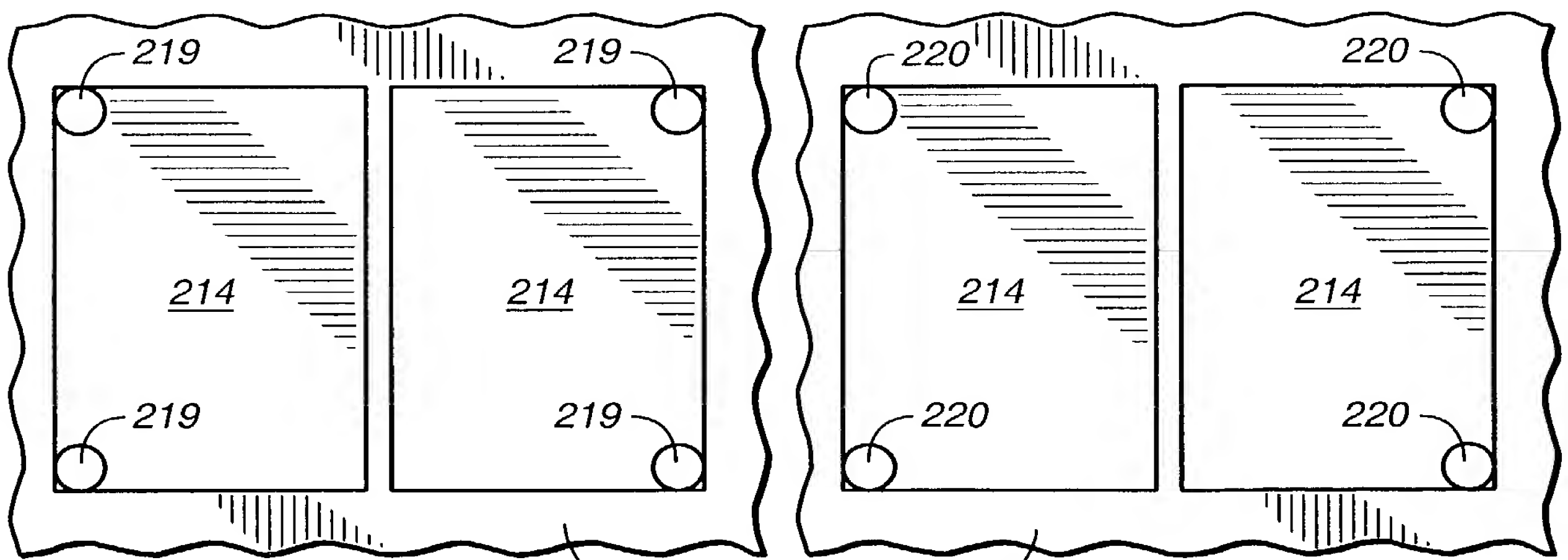
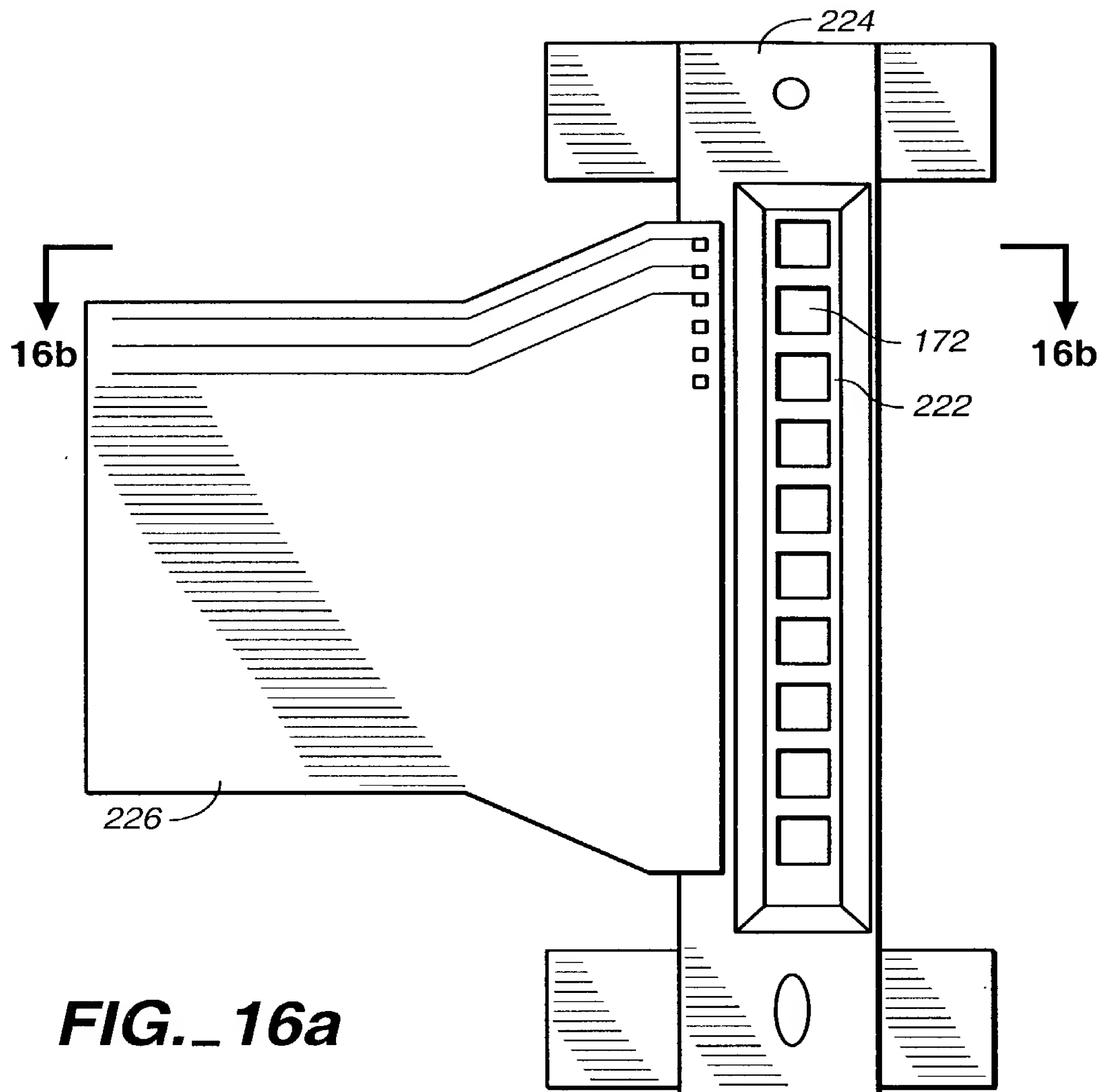
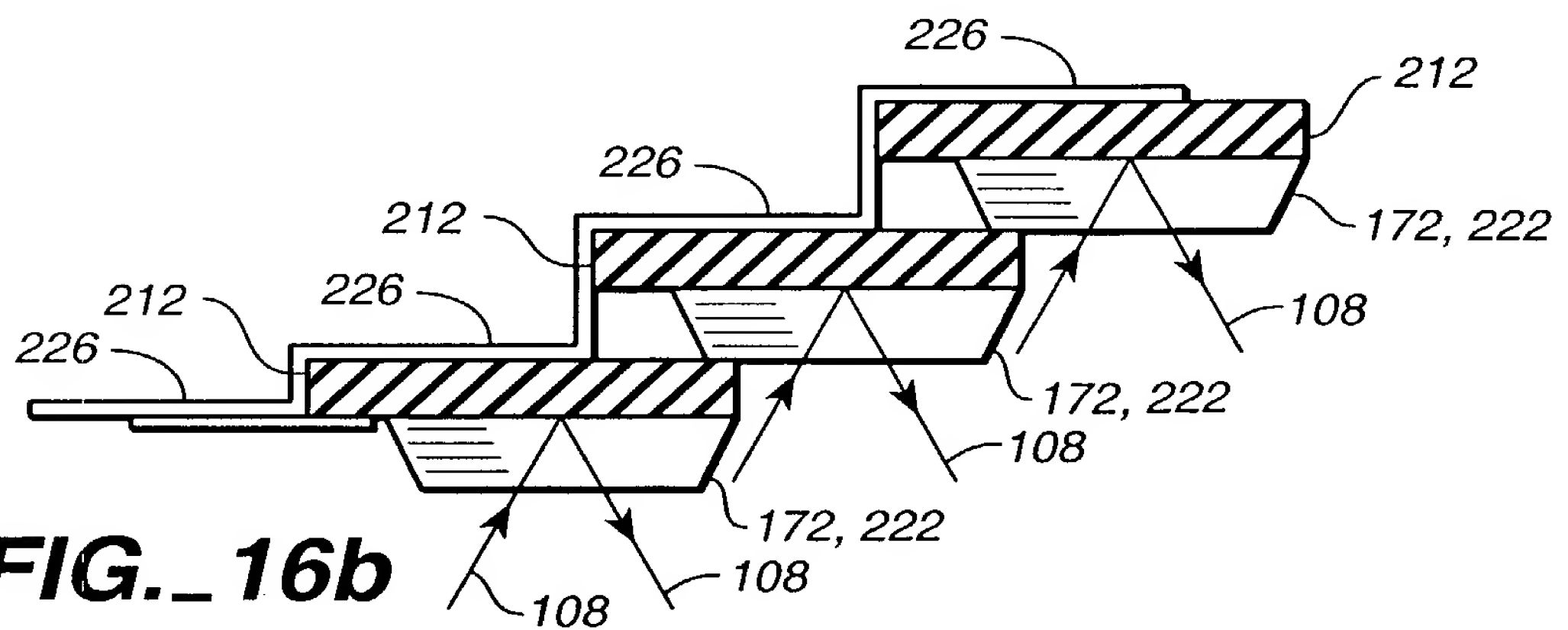


FIG. 14**FIG. 15****FIG. 15a****FIG. 15b**

**FIG. 16a****FIG. 16b**

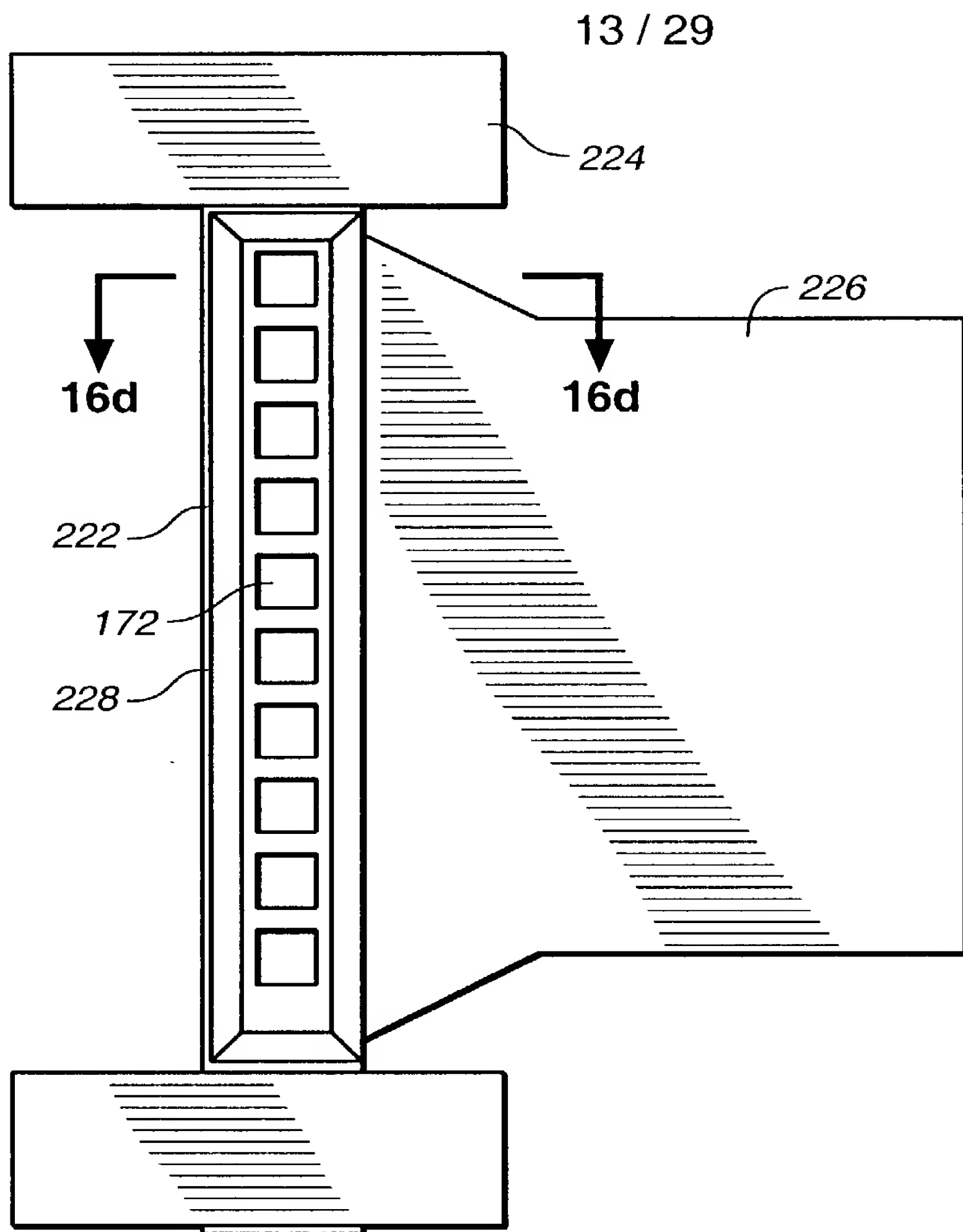


FIG. 16c

FIG. 16d

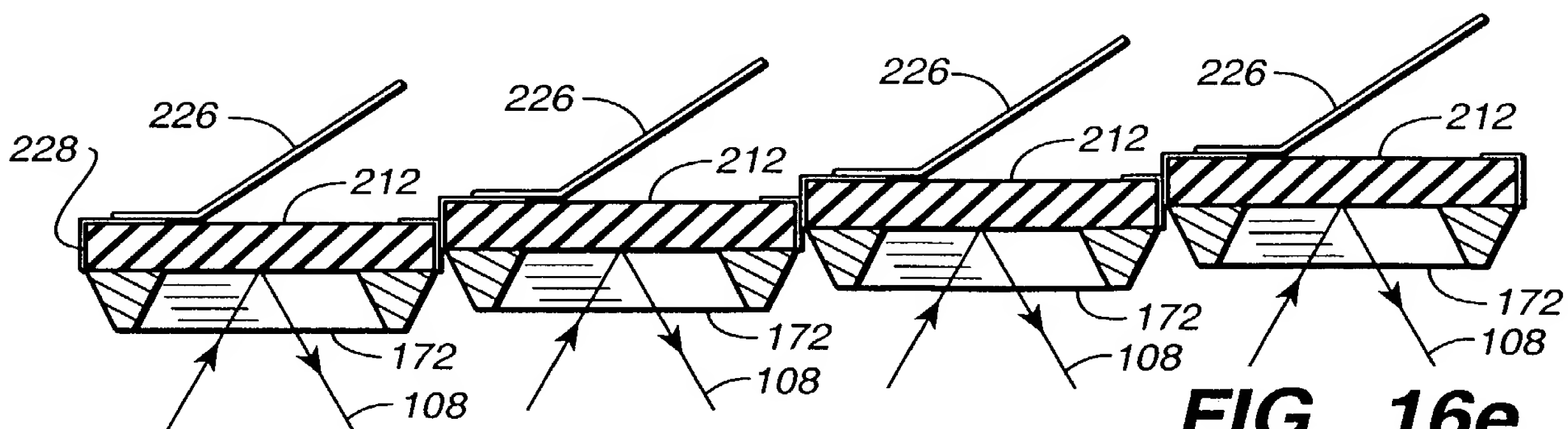
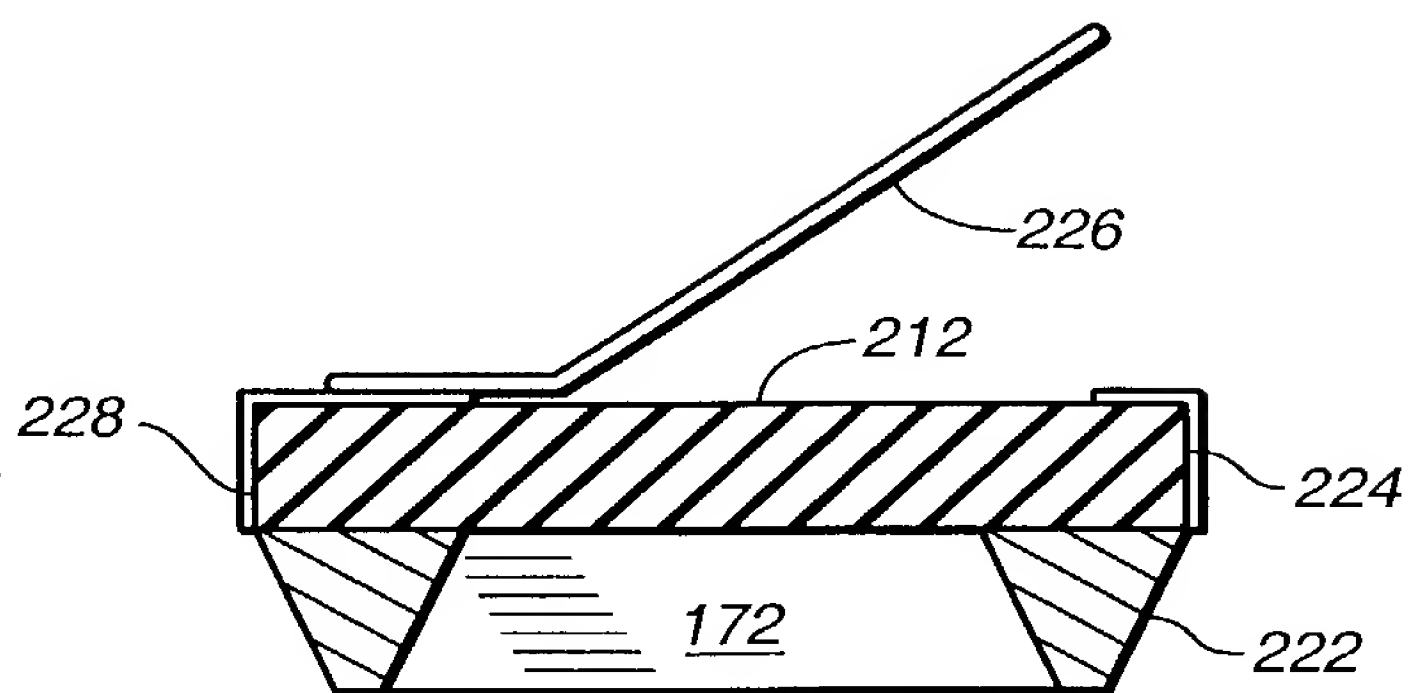
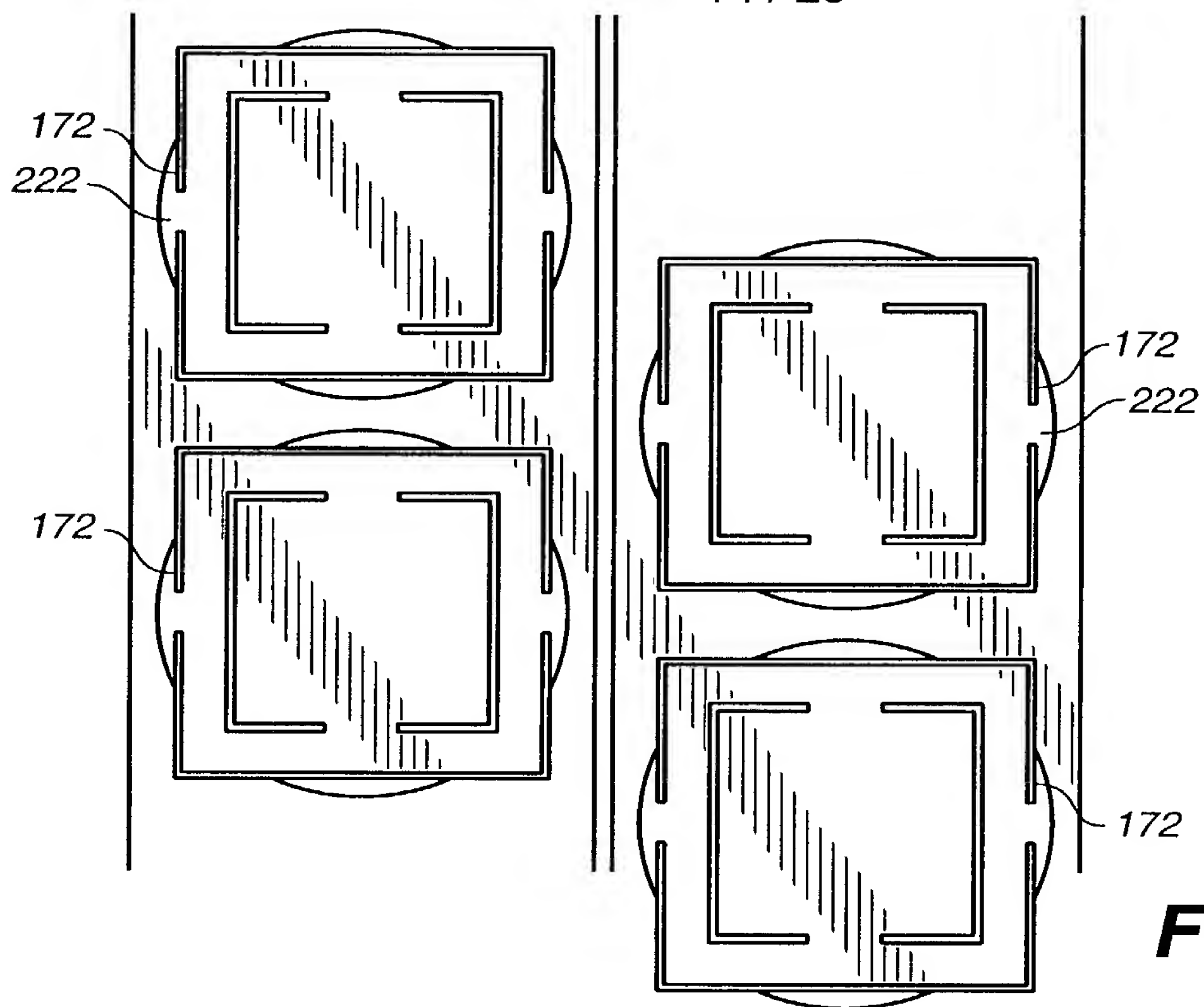
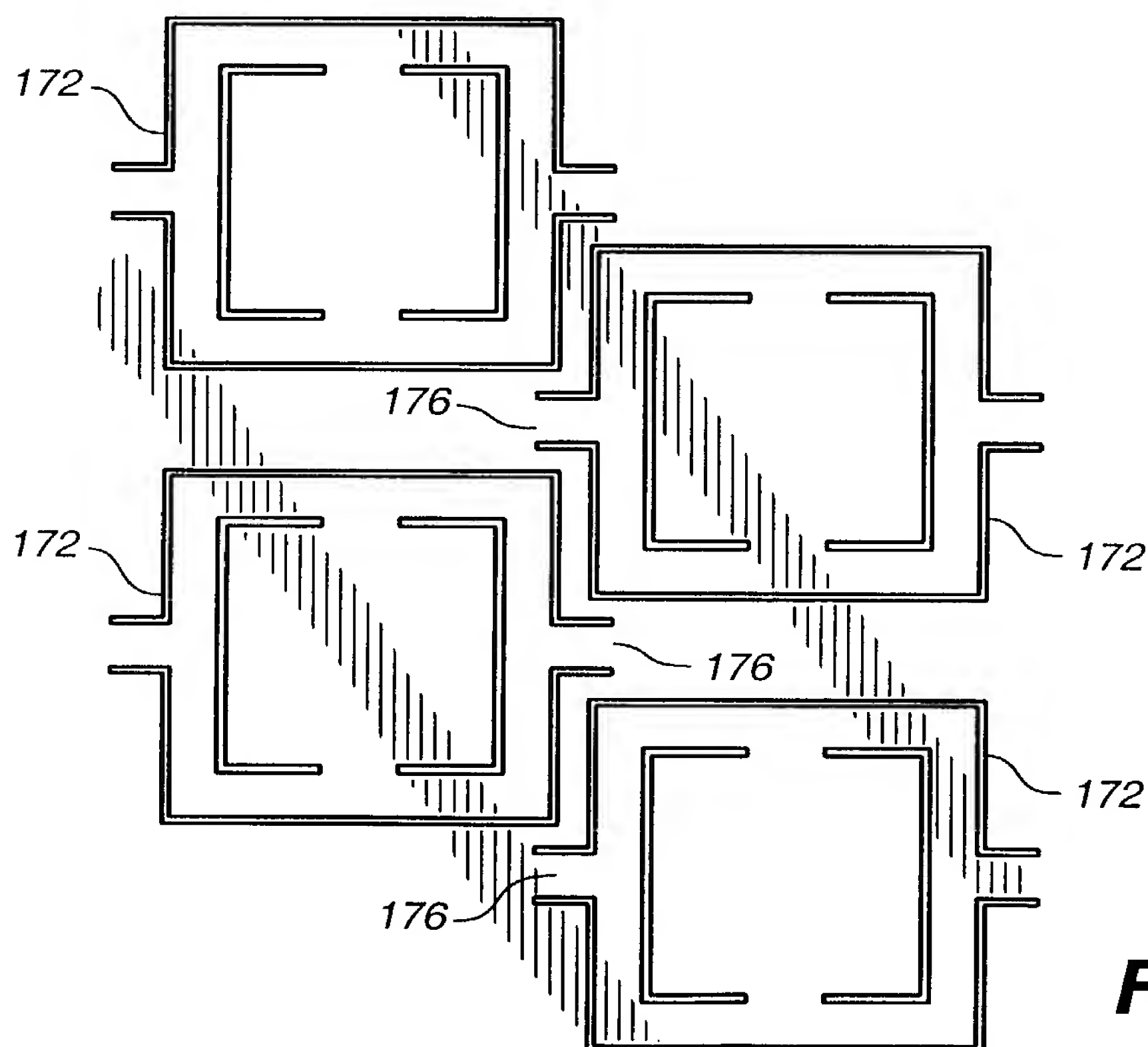


FIG. 16e

**FIG._17a****FIG._17b**

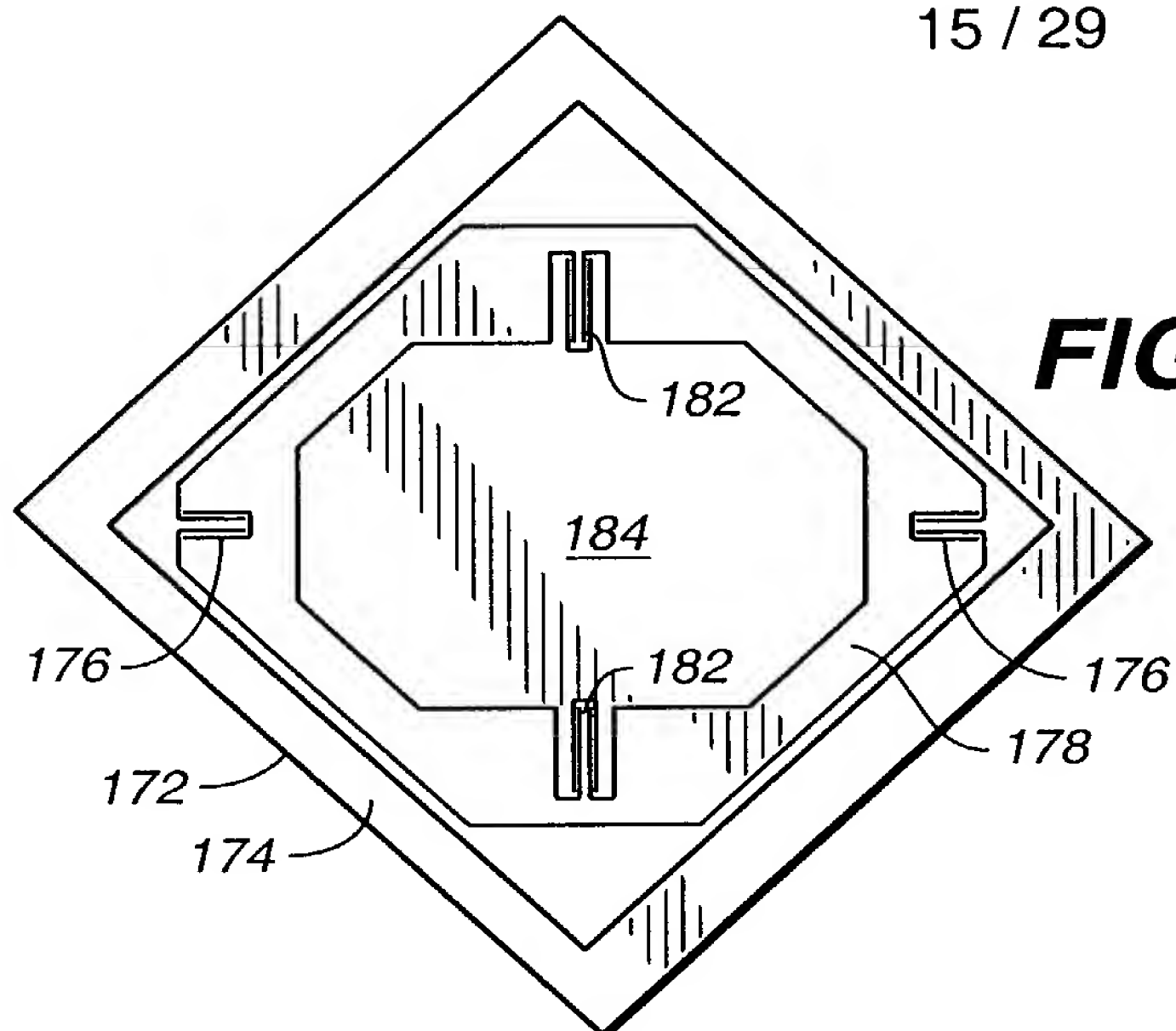


FIG. 18a

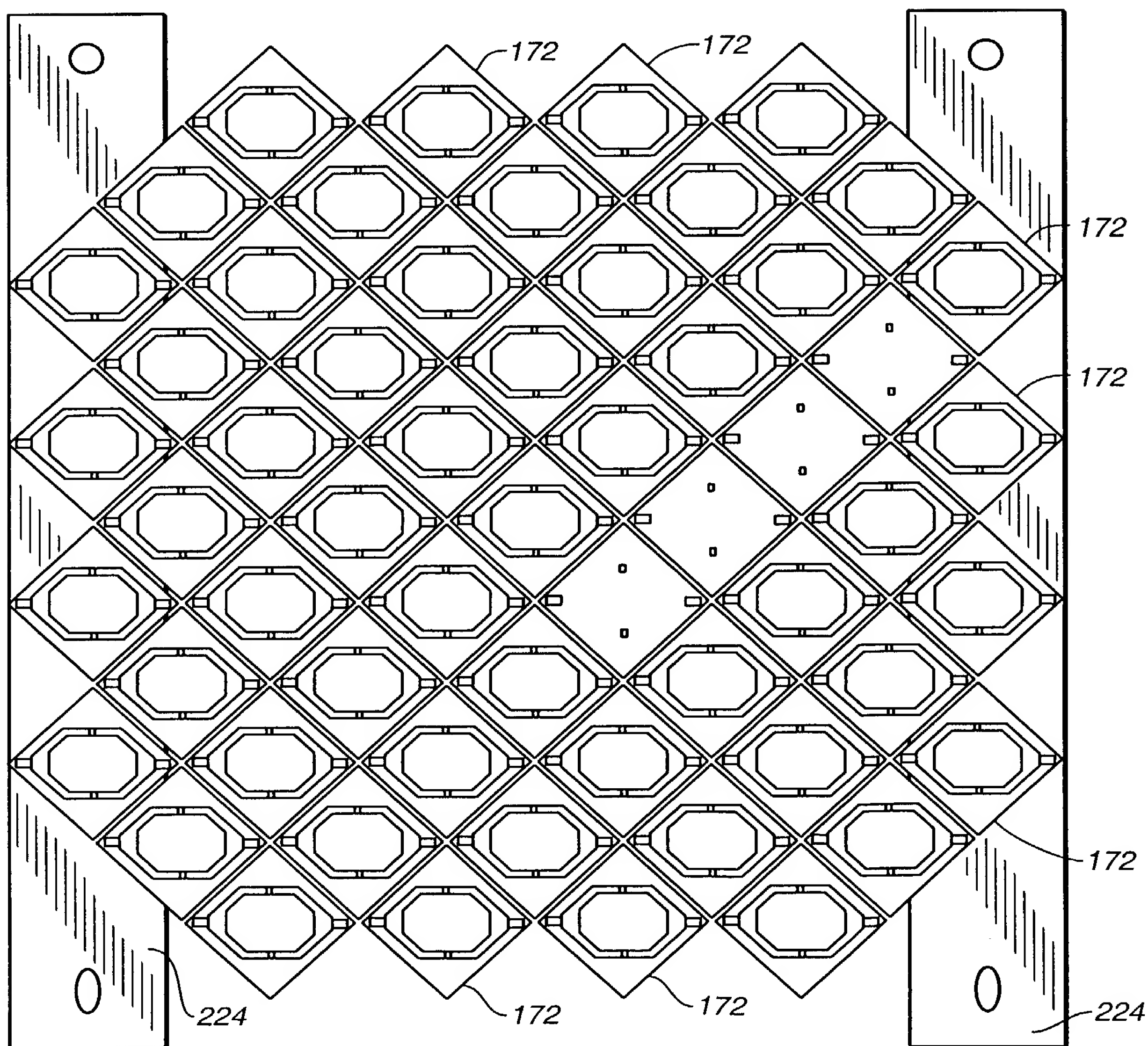
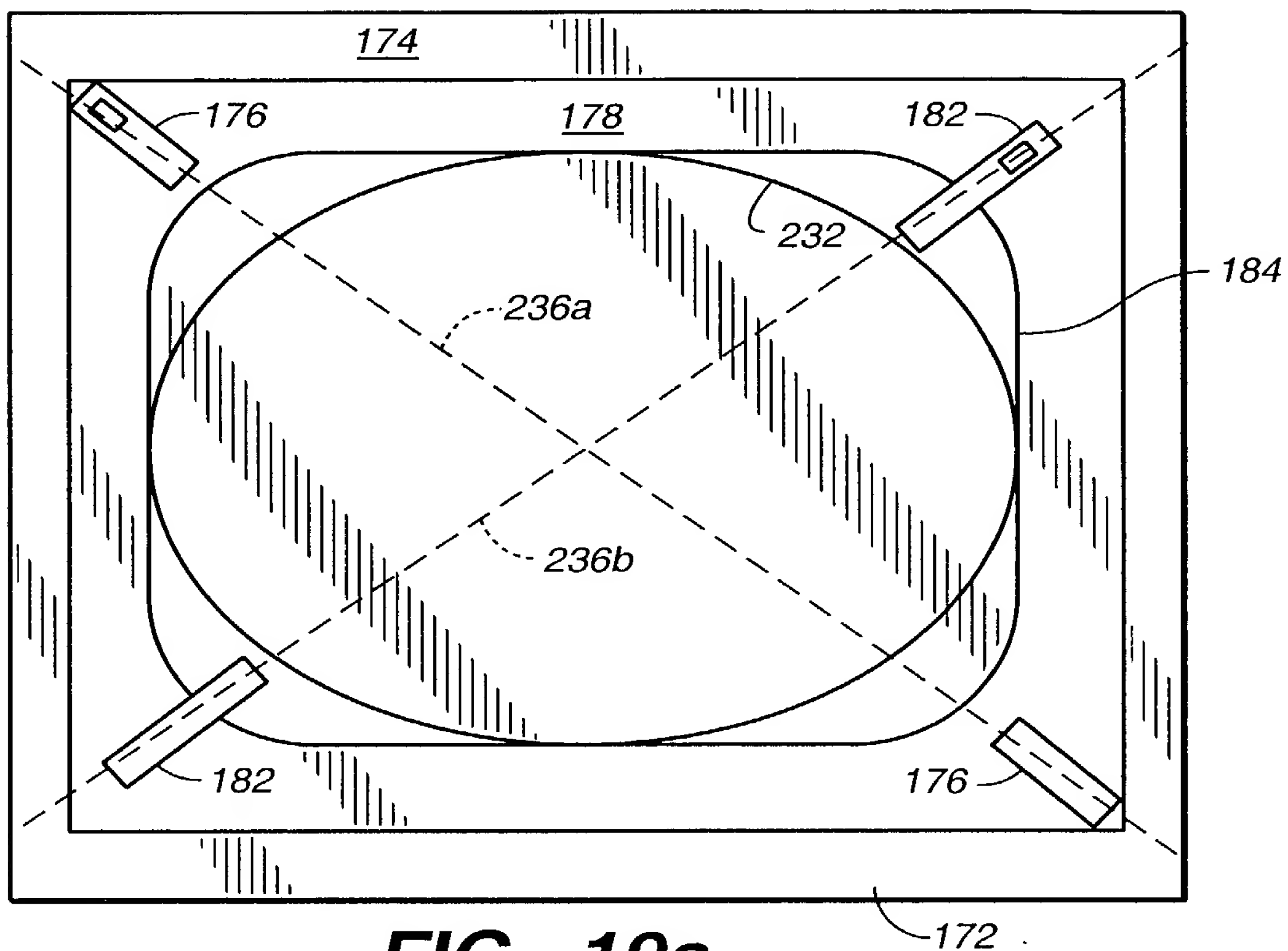
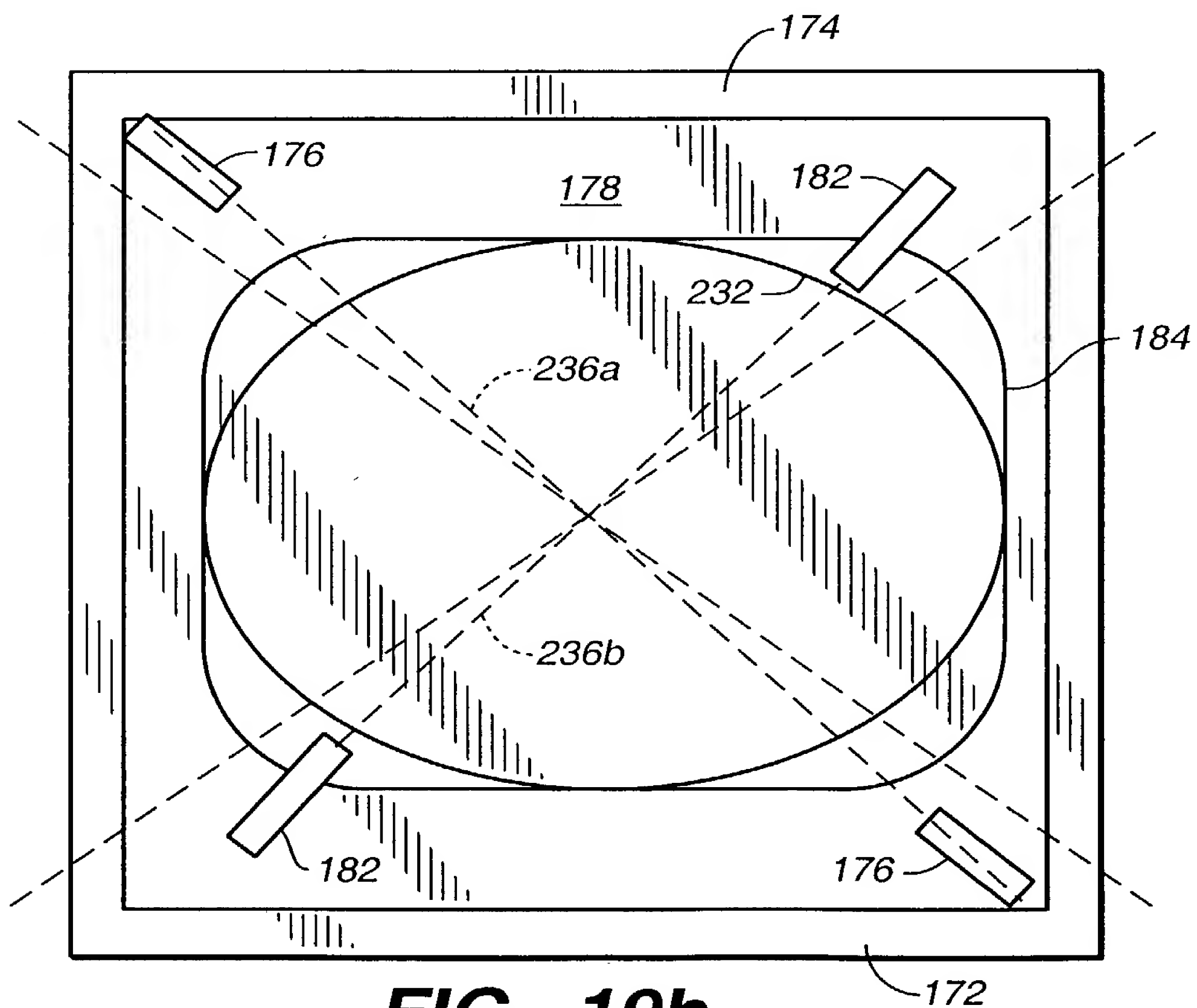
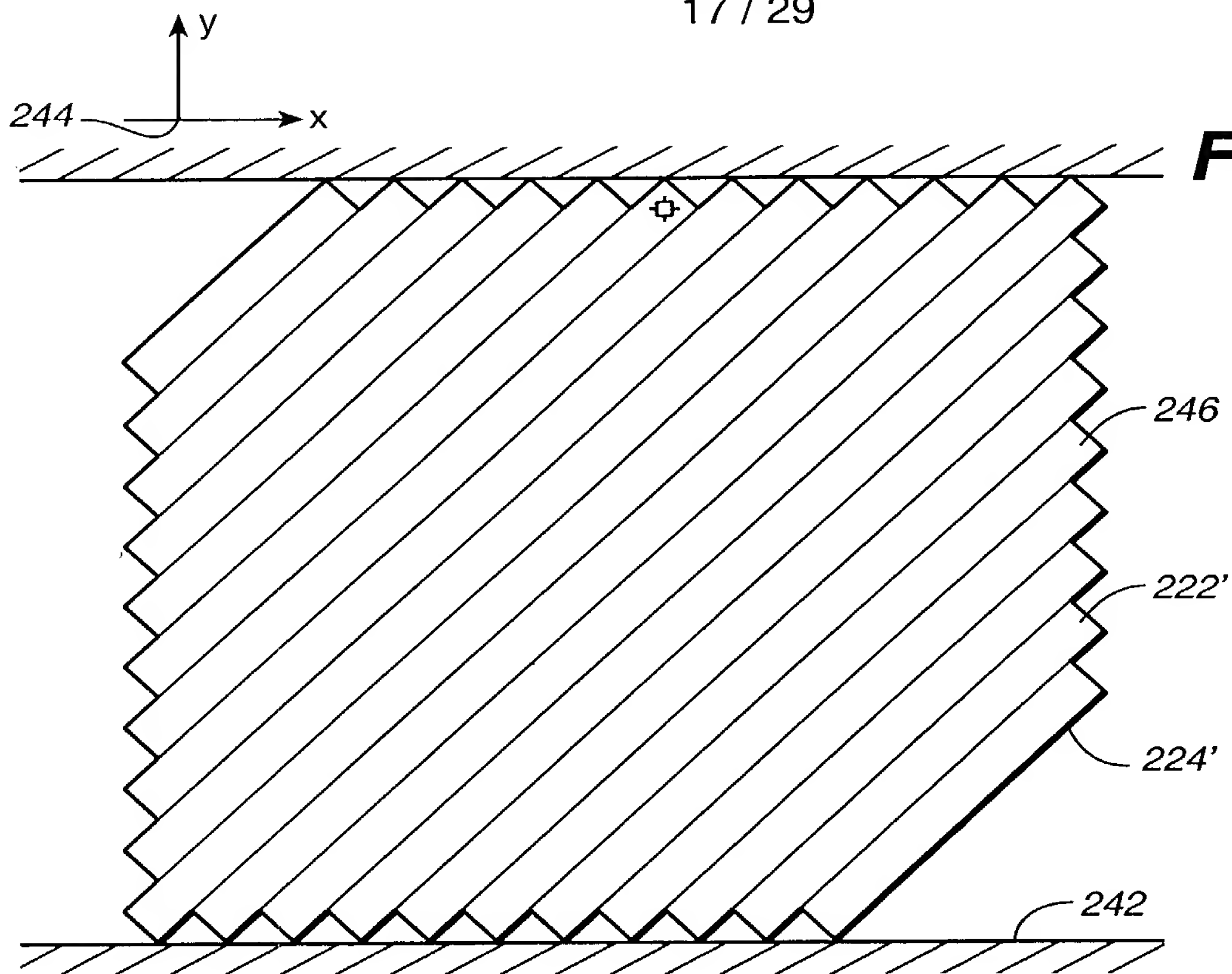
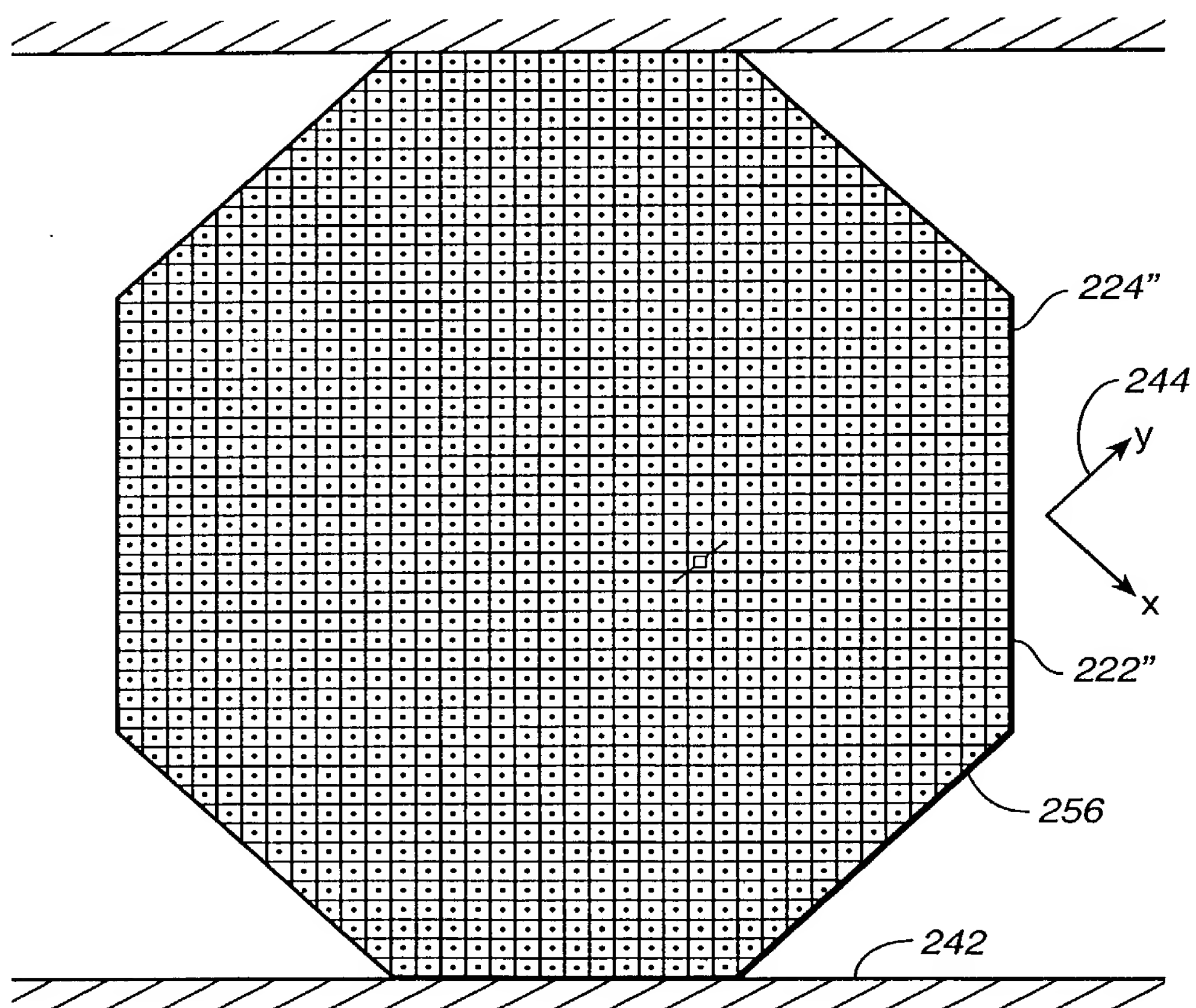
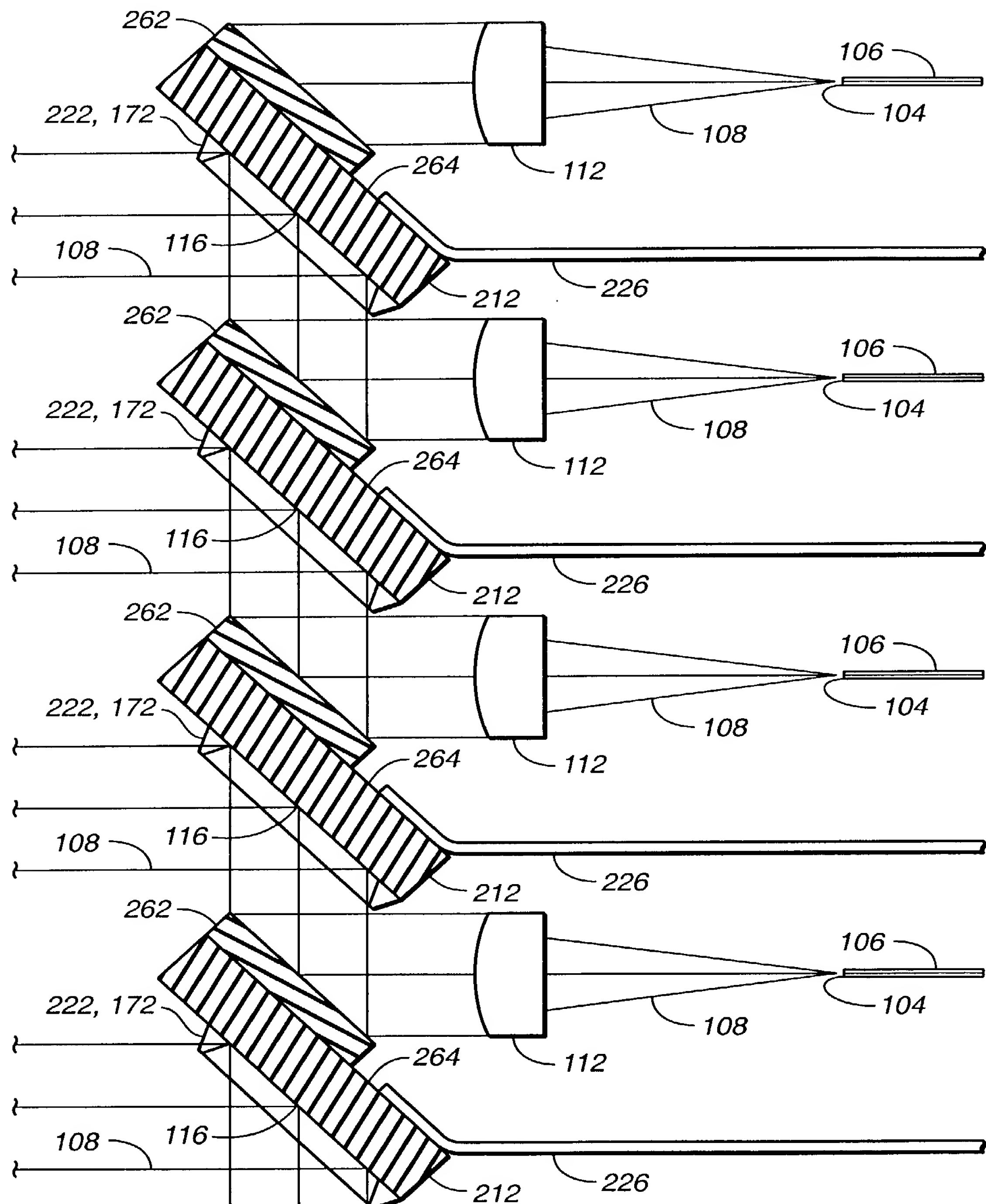


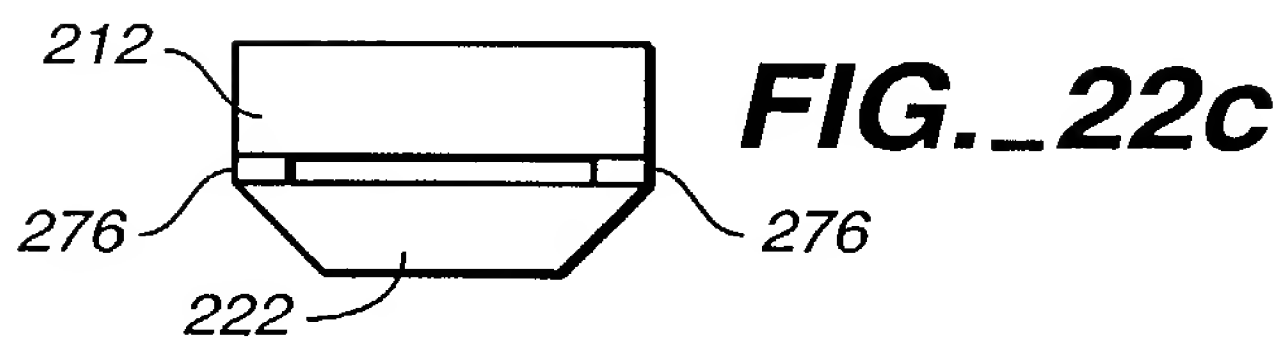
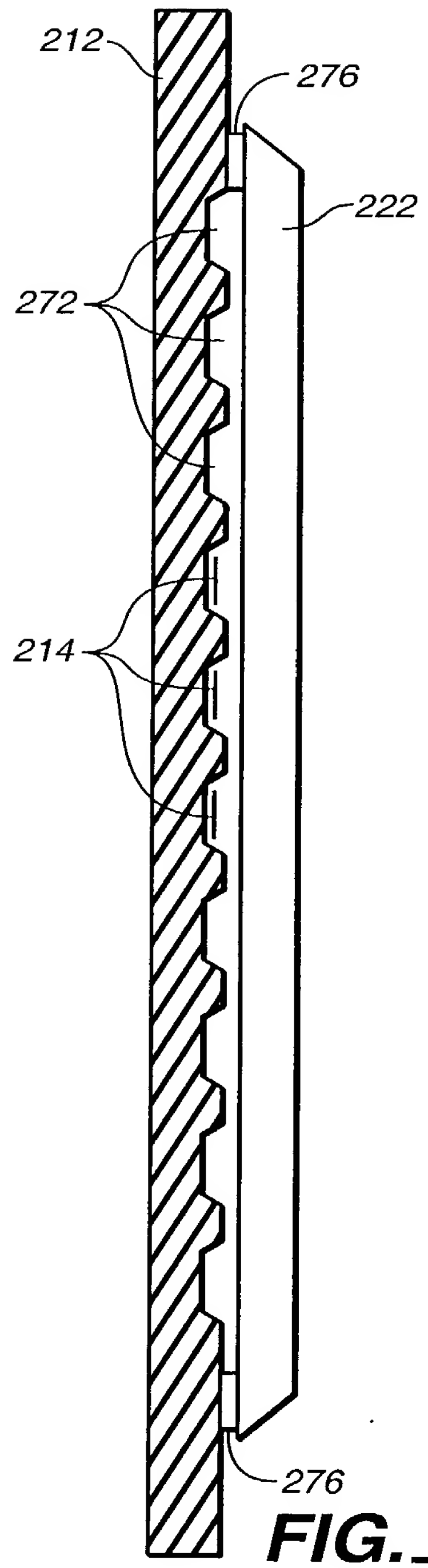
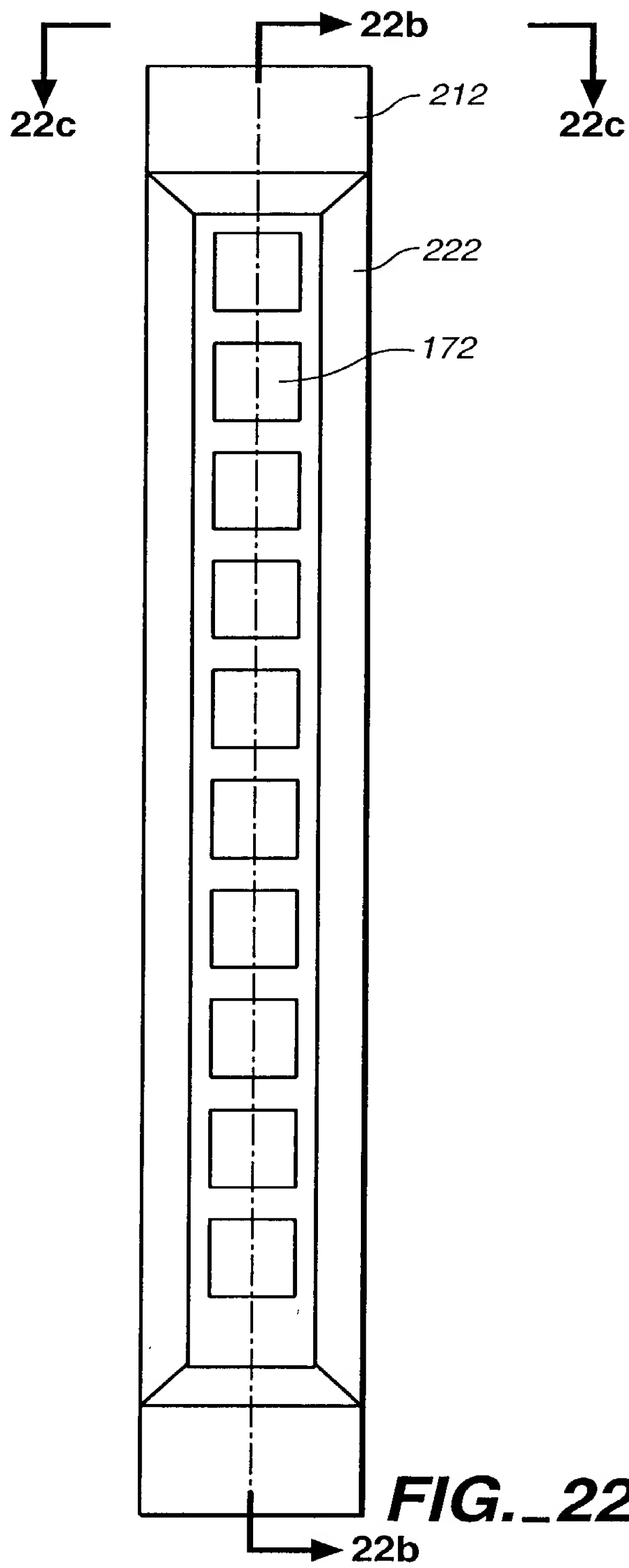
FIG. 18b

Downloaded from ascelibrary.org by University of California, San Diego on 06/06/15

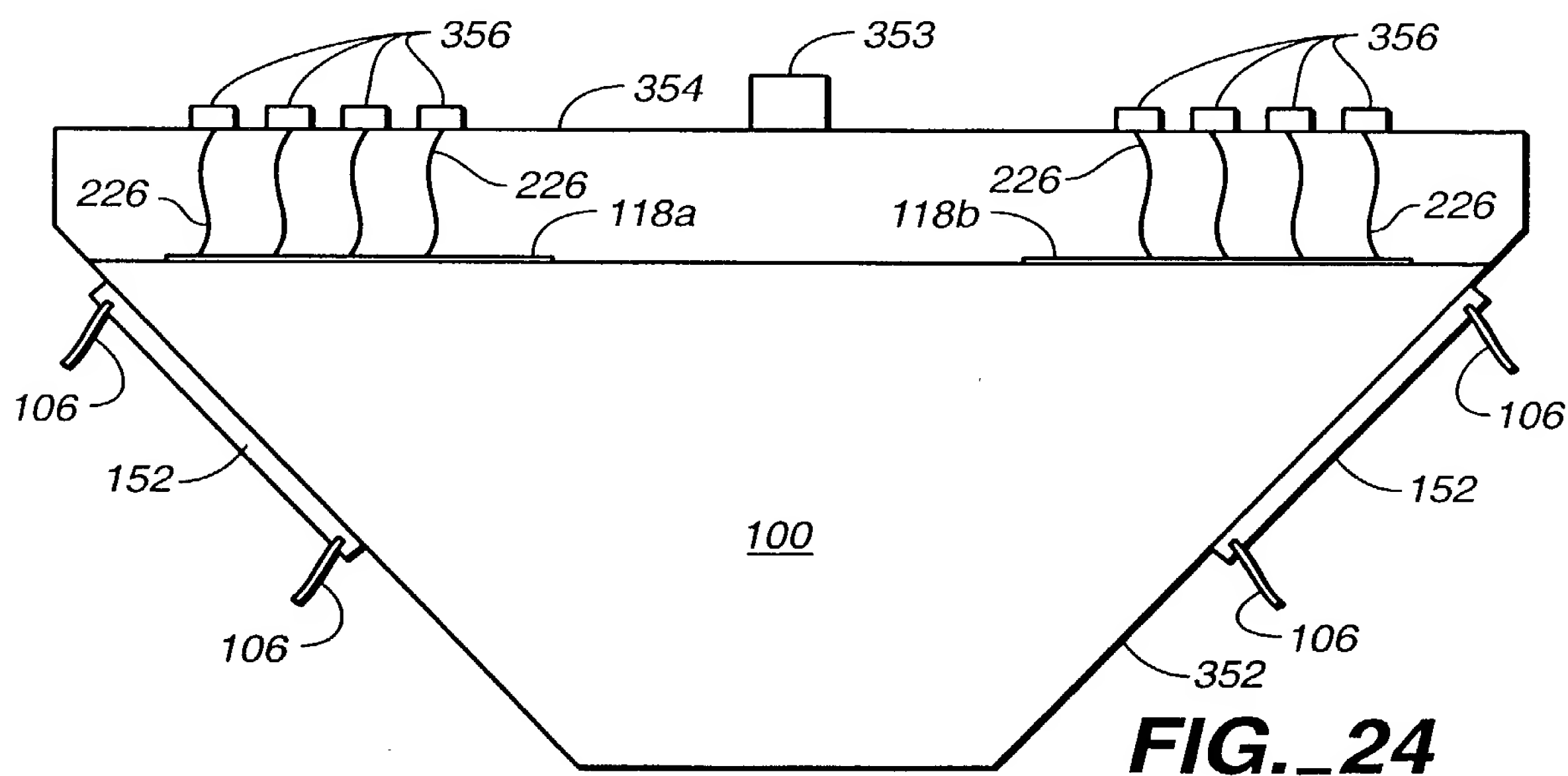
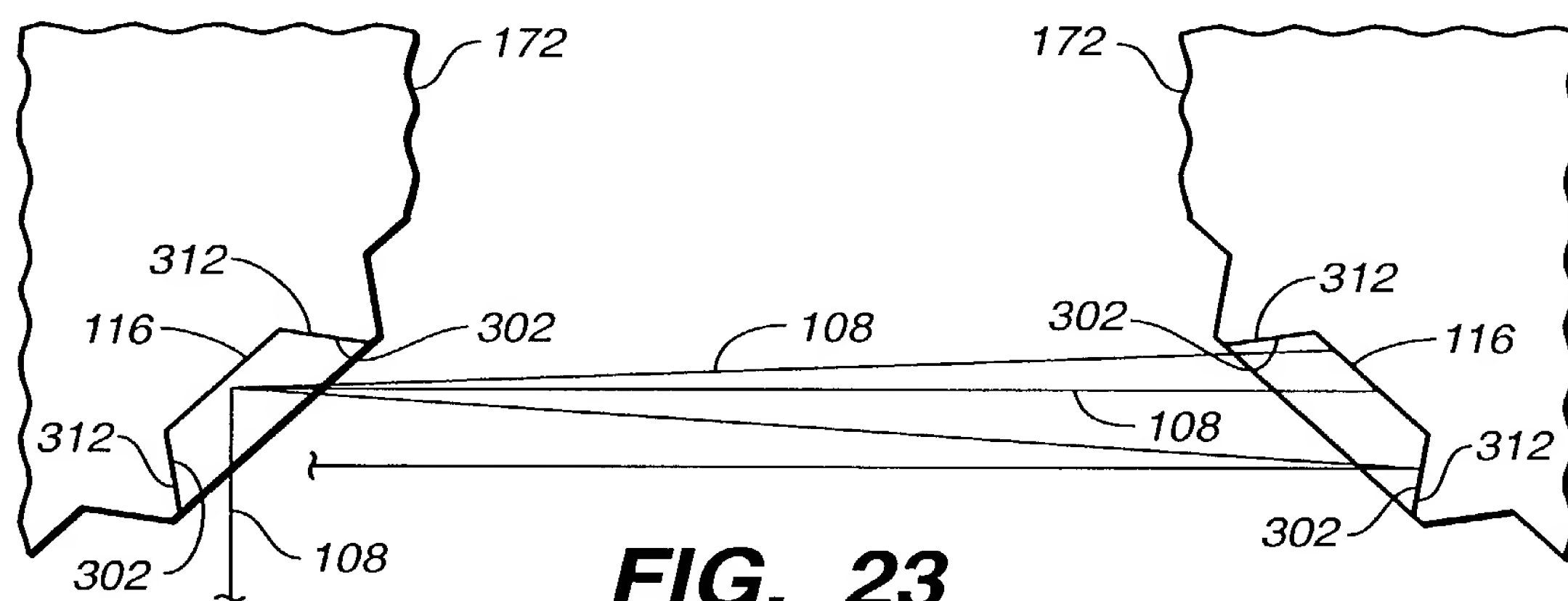
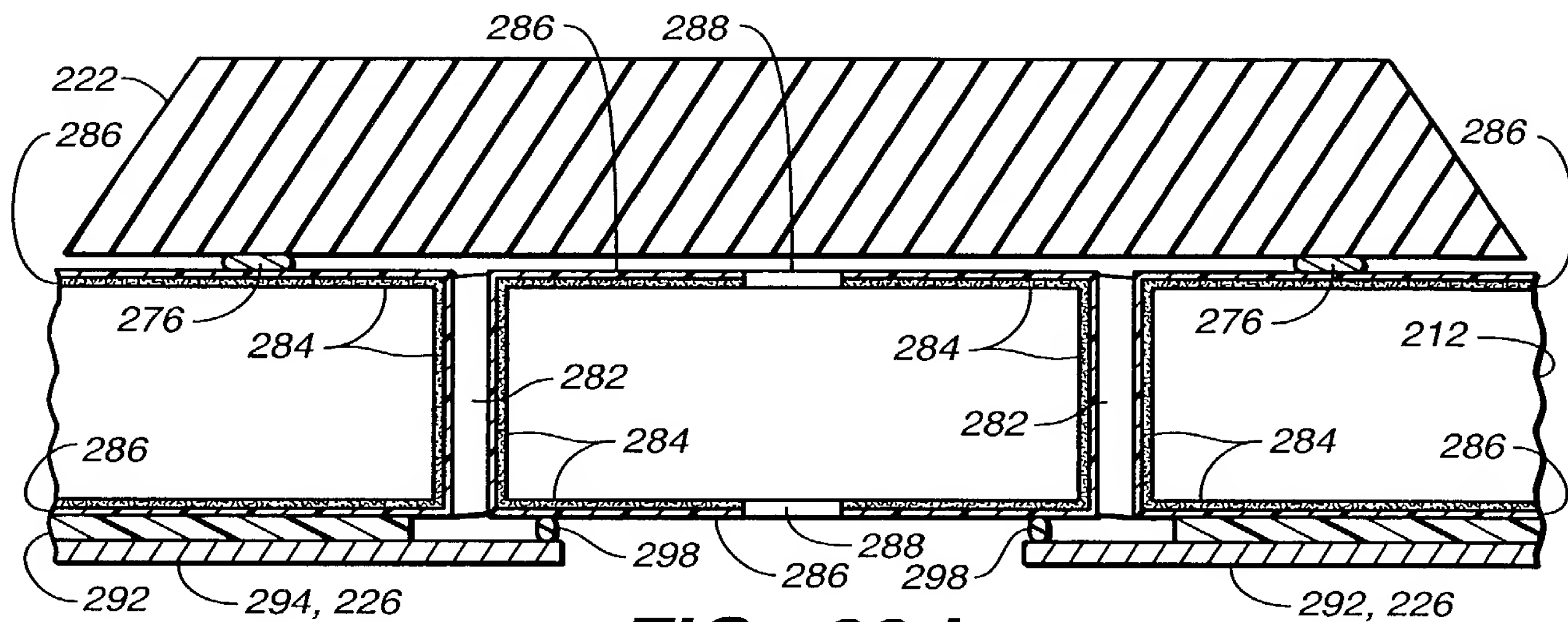
**FIG. 19a****FIG. 19b**

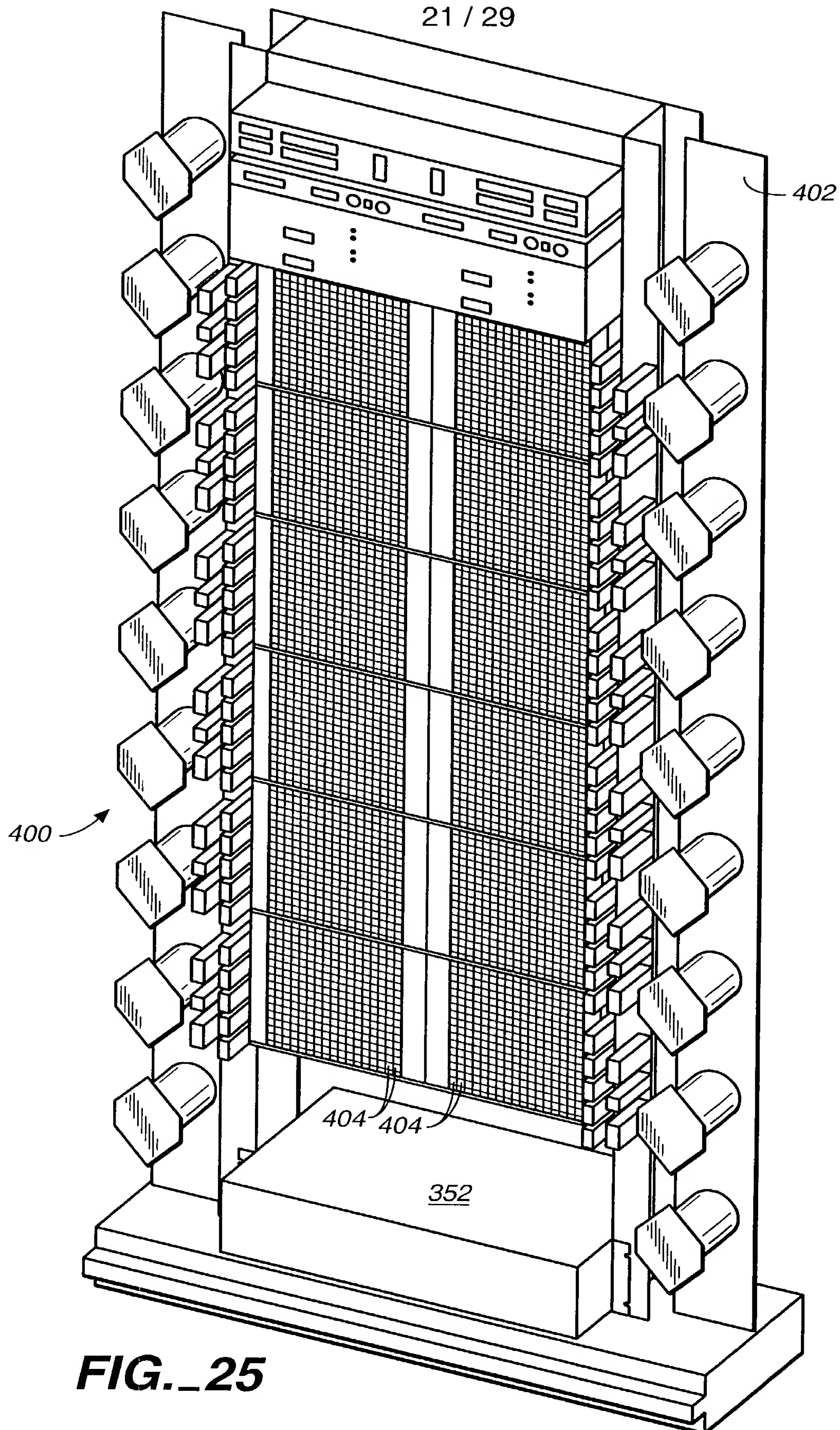
**FIG. 20a****FIG. 20b**

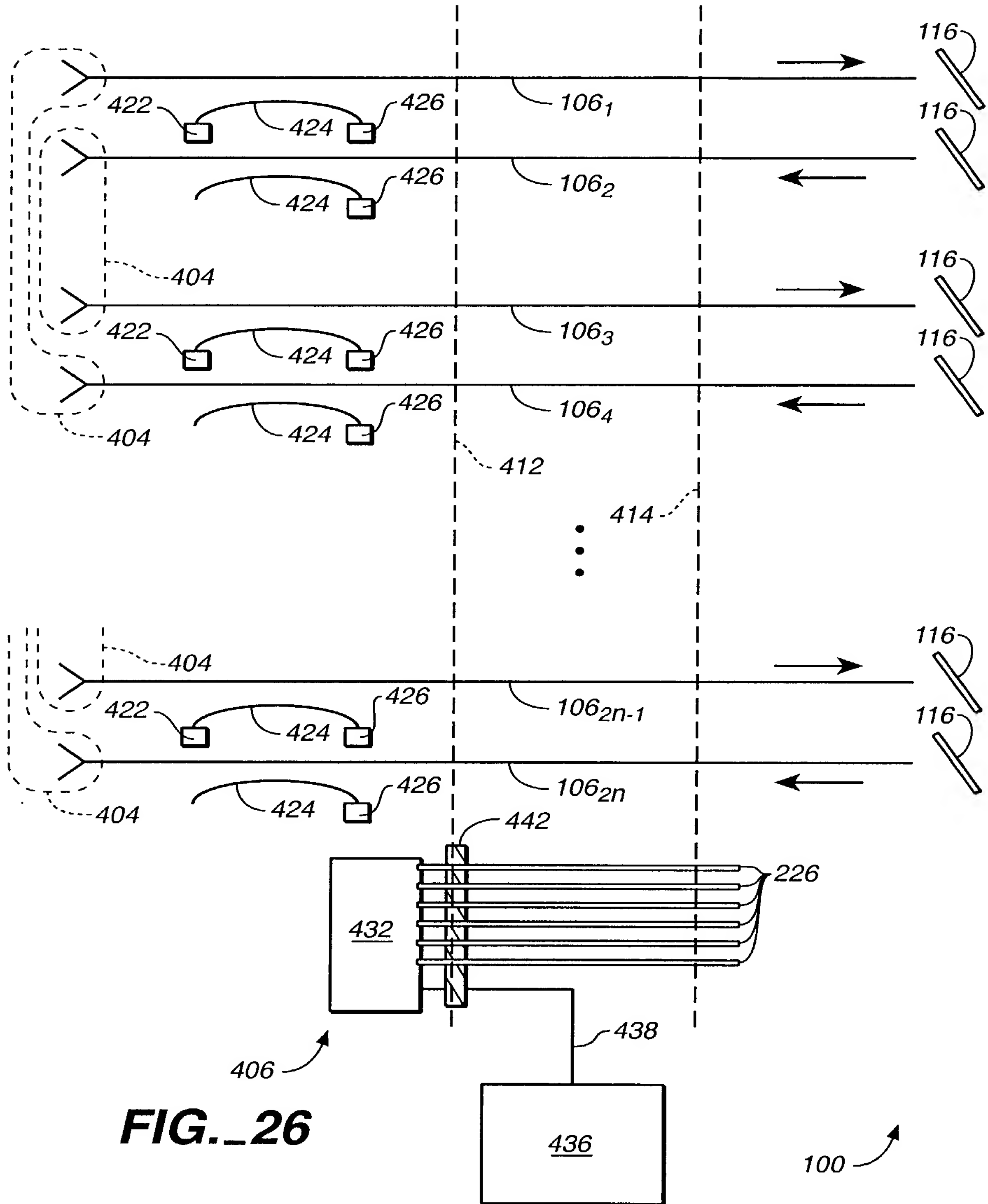
**FIG. 21**



20 / 29





**FIG. 26**

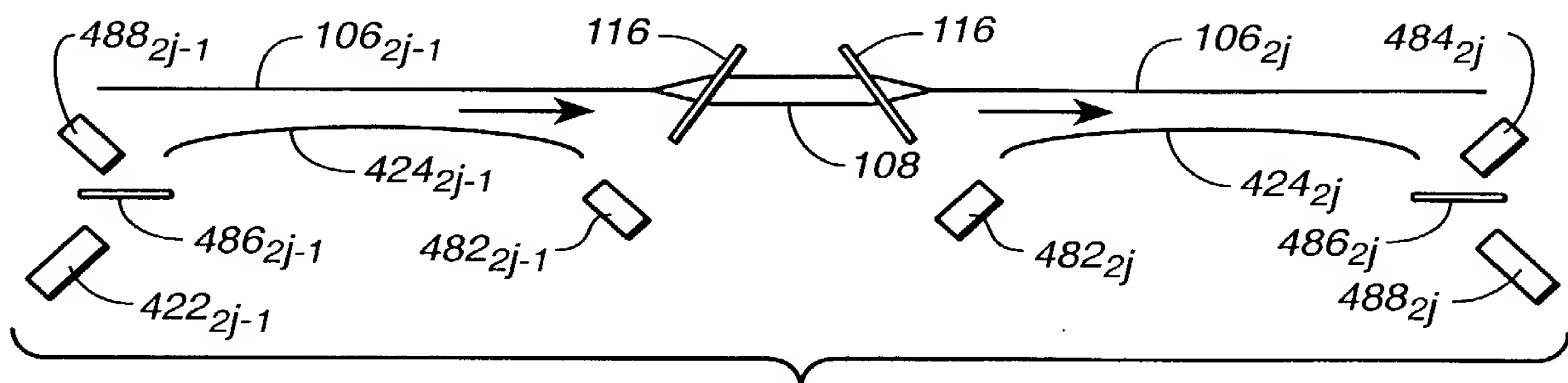


FIG. 26a

FIG. 26b

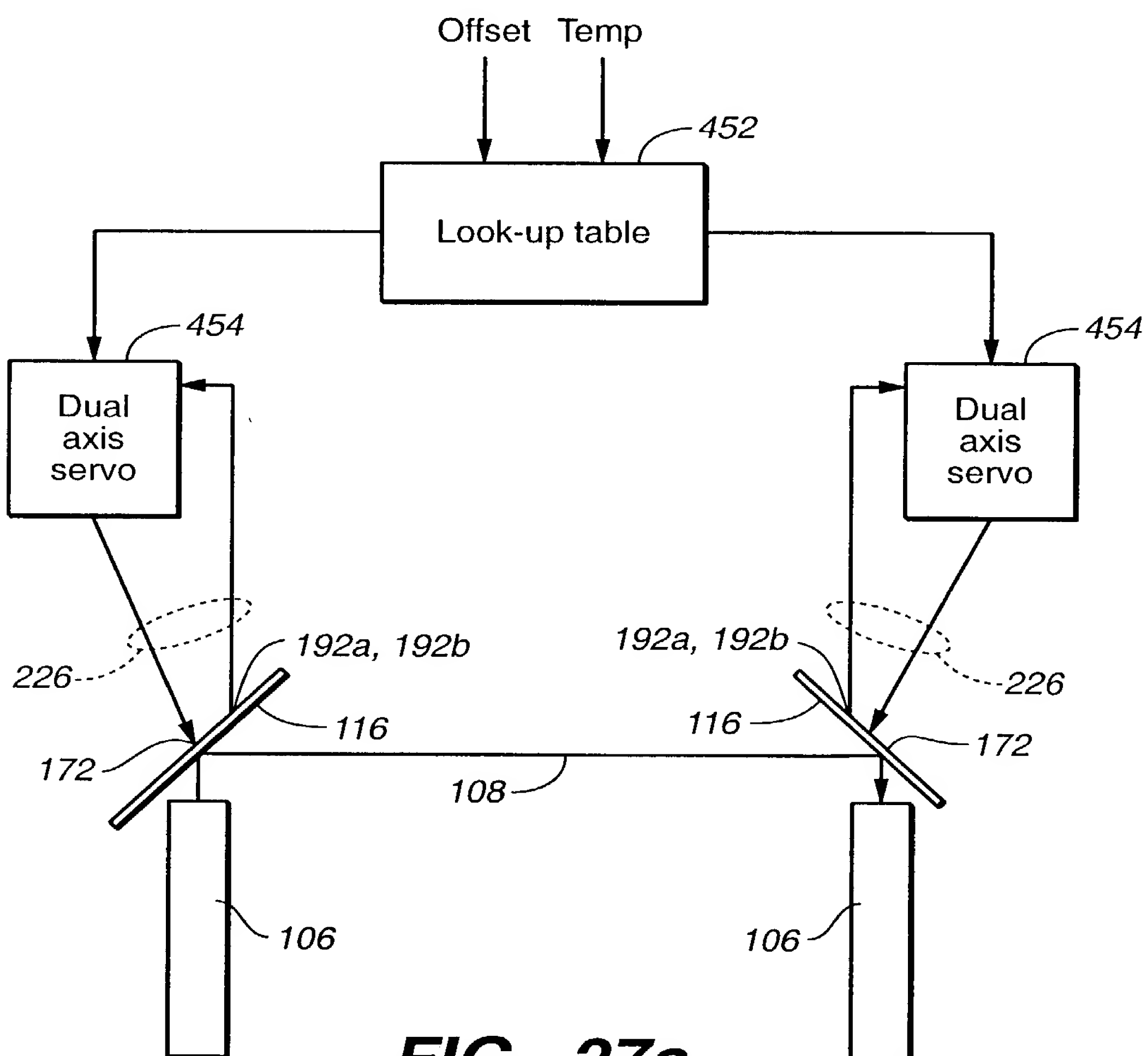
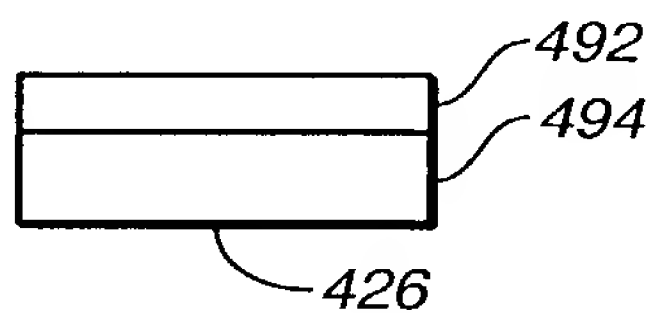
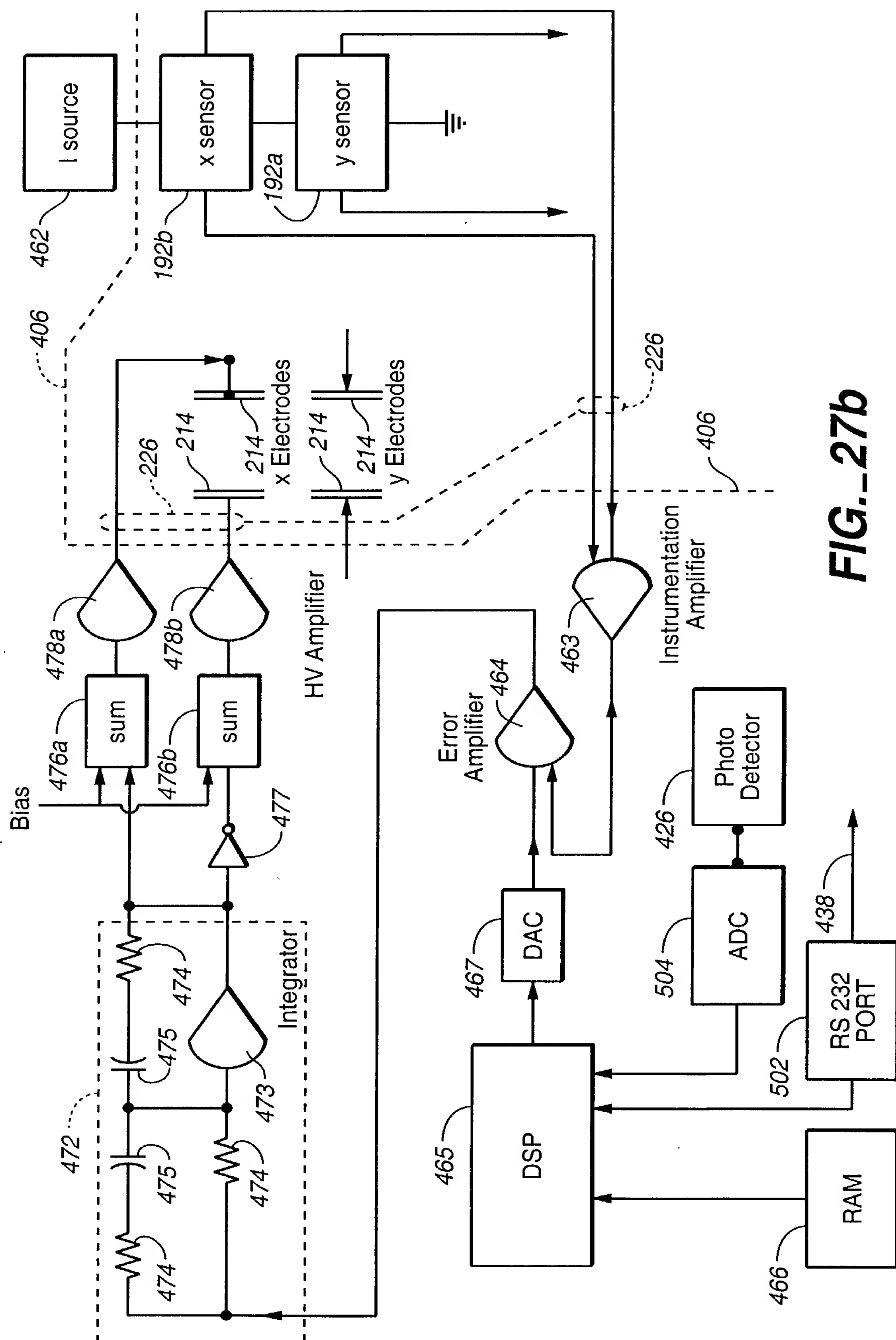


FIG. 27a



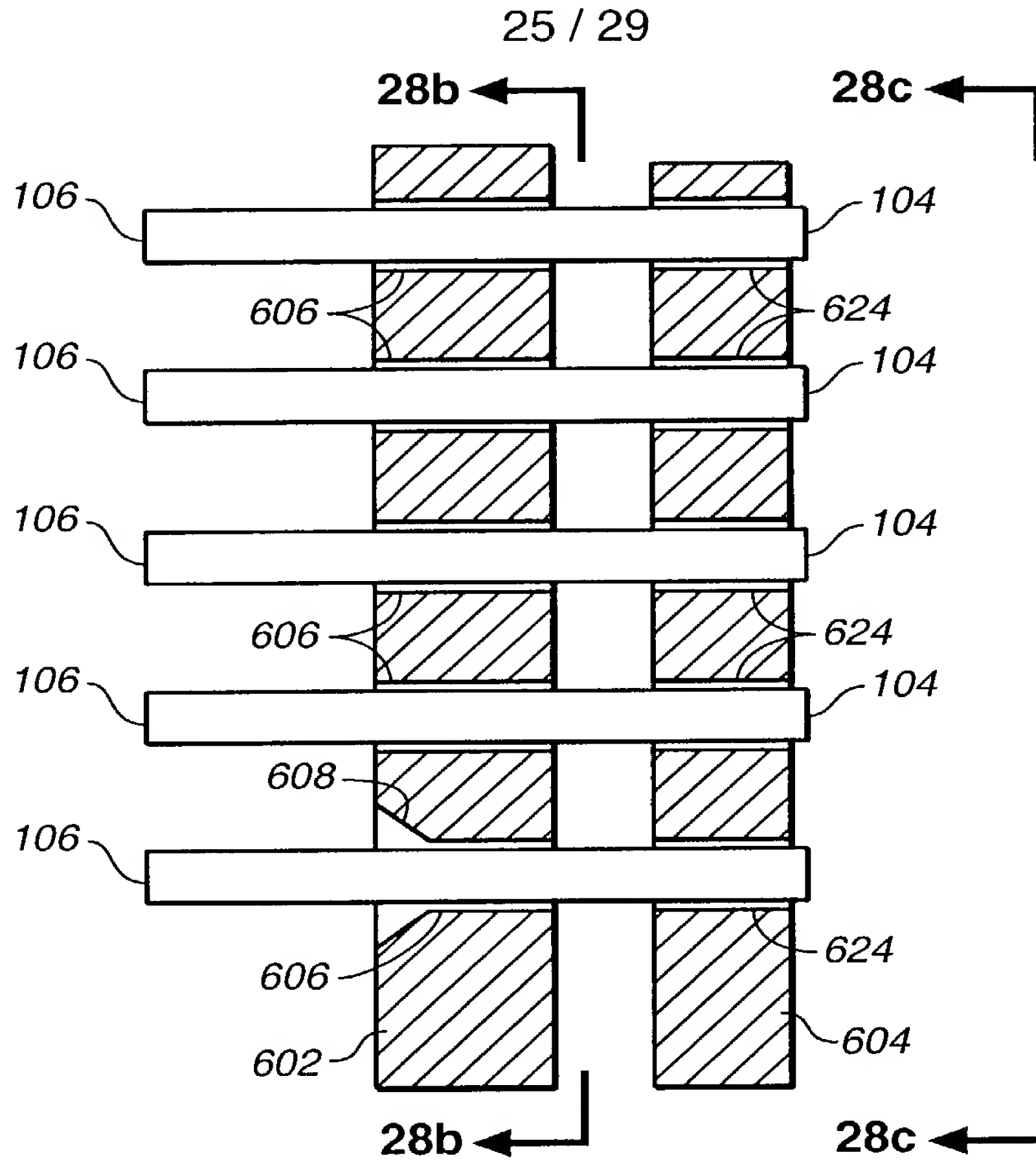


FIG._28a

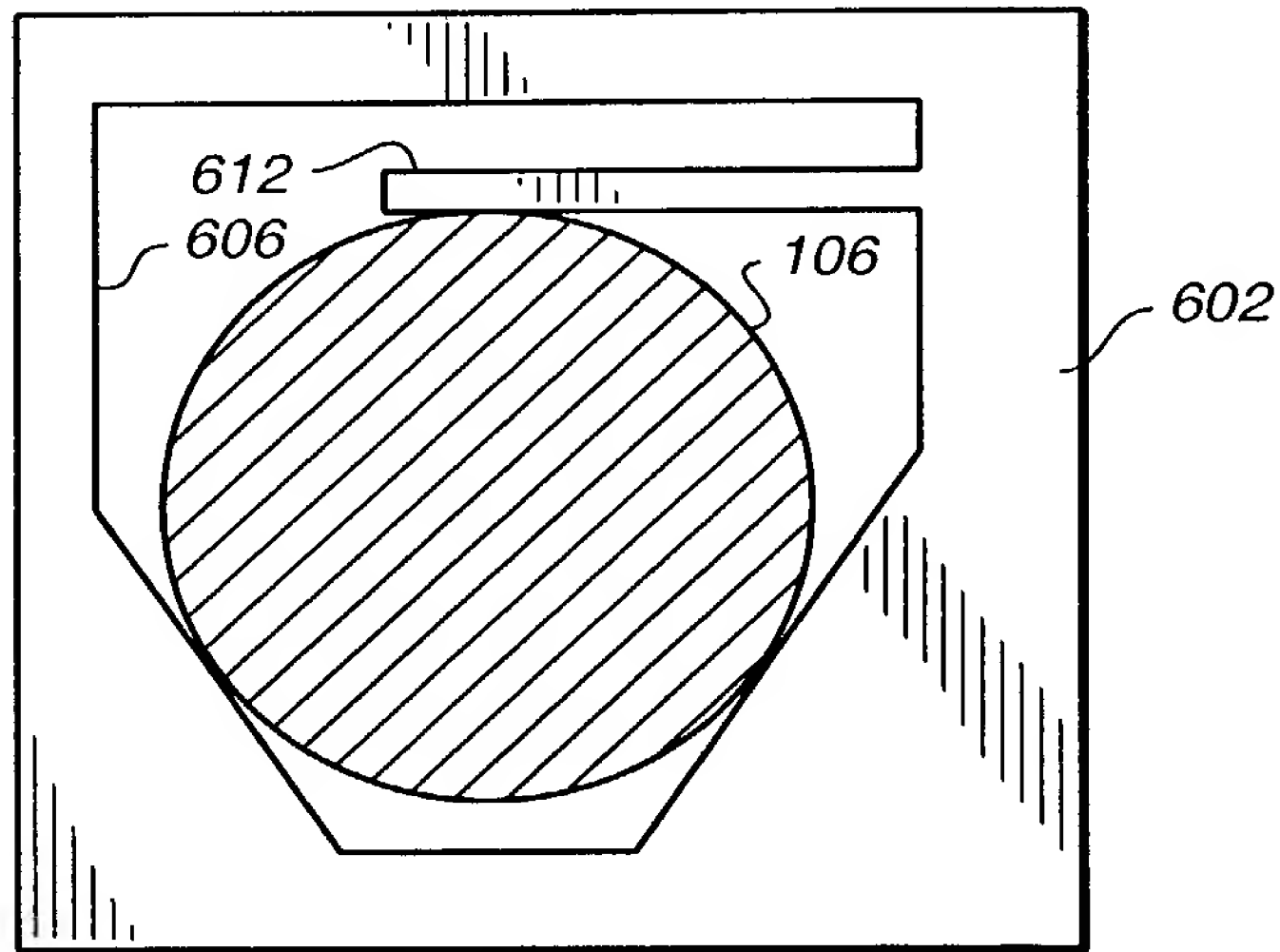


FIG._28b

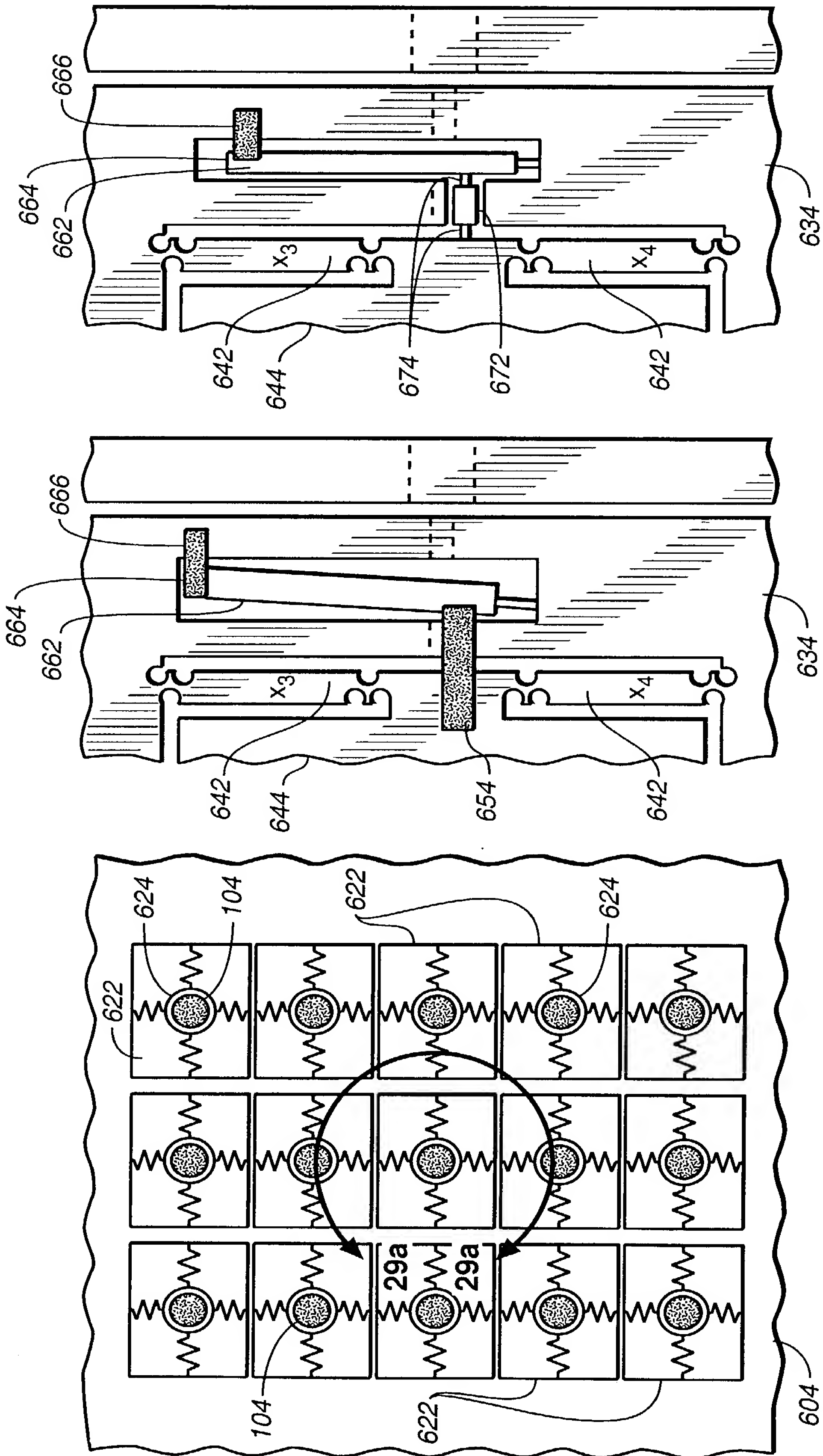


FIG.-28c

FIG.-29b

FIG.-29c

FIG. 29a

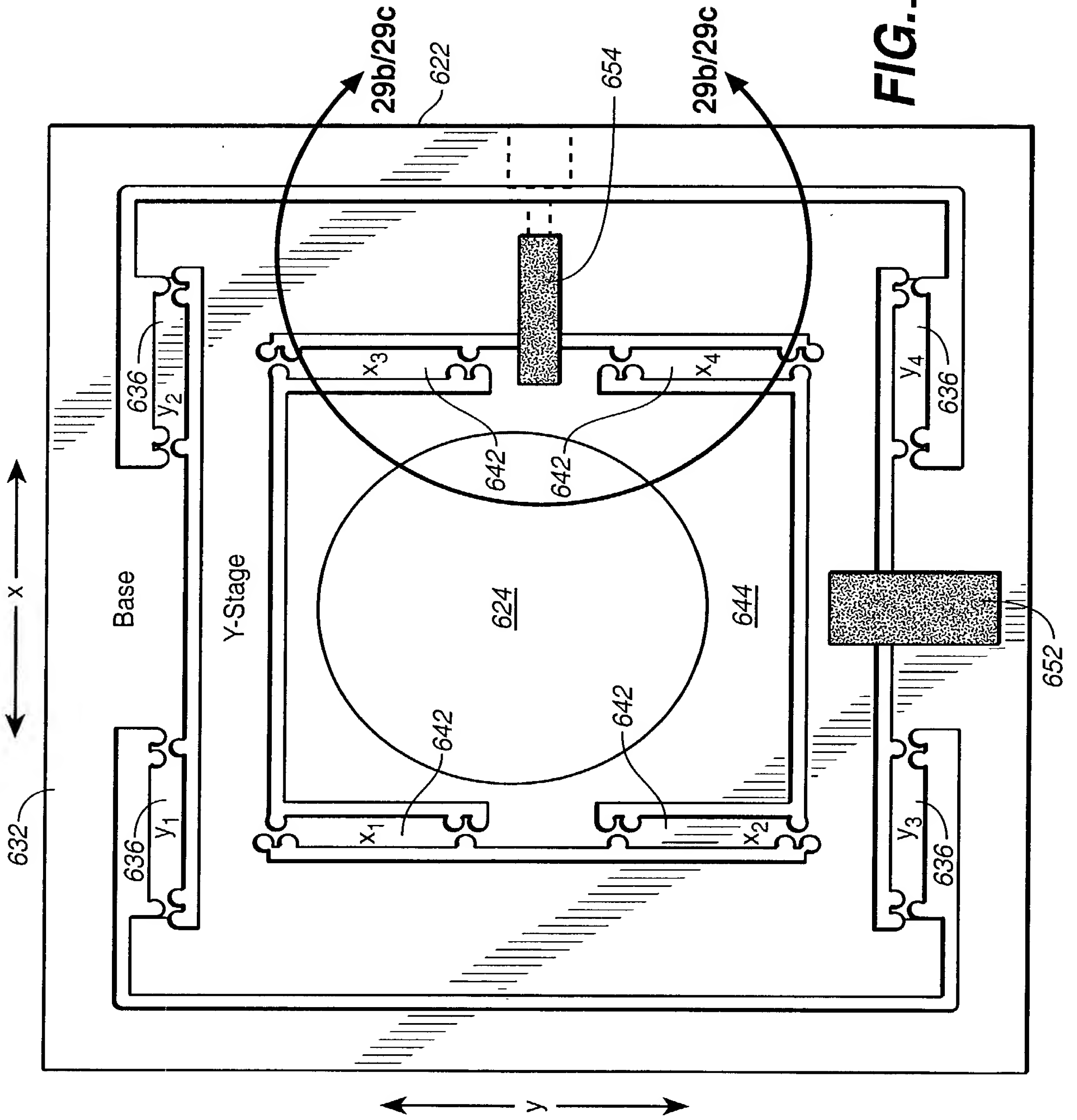


FIG. 29a

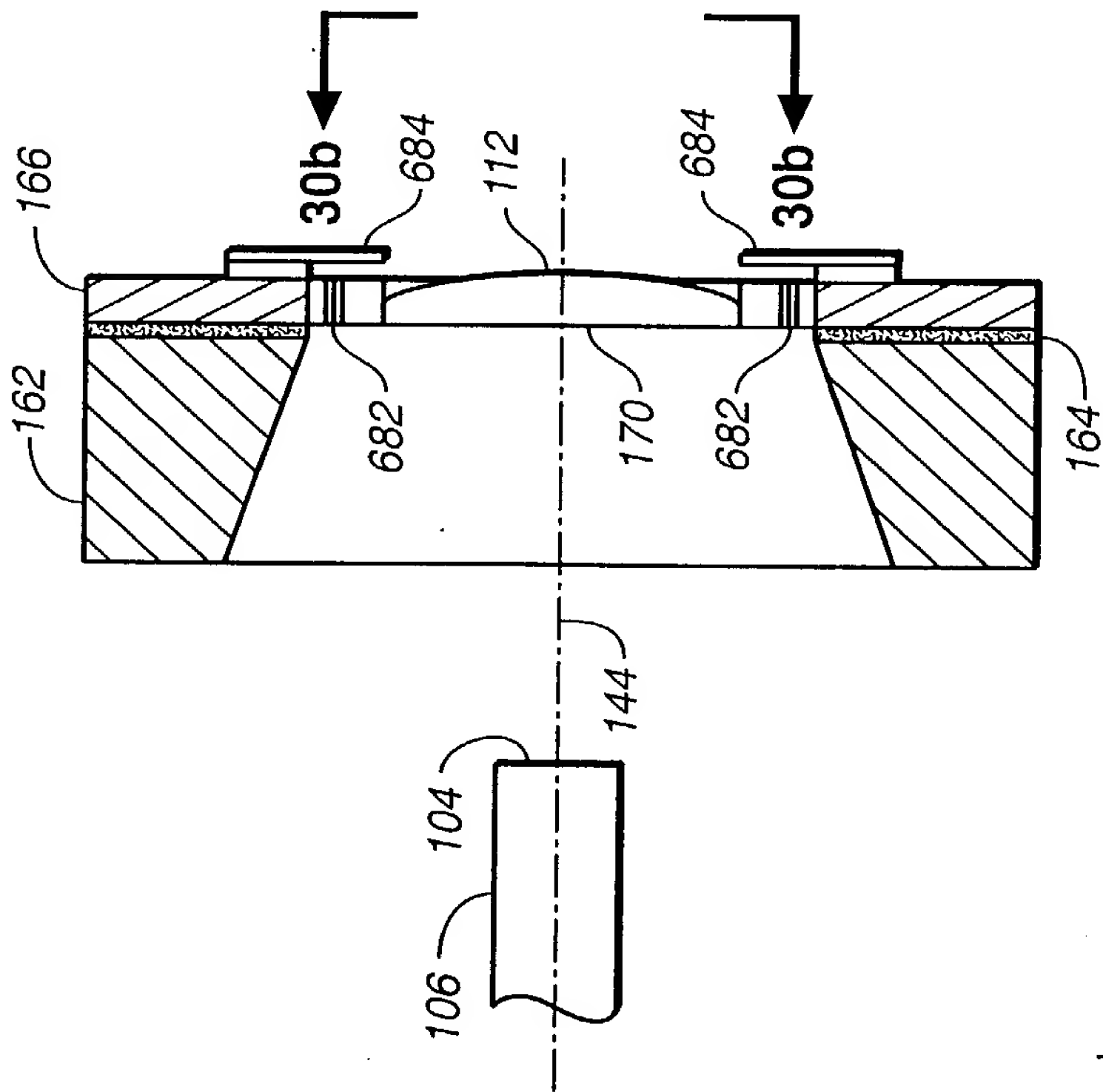


FIG. 30a

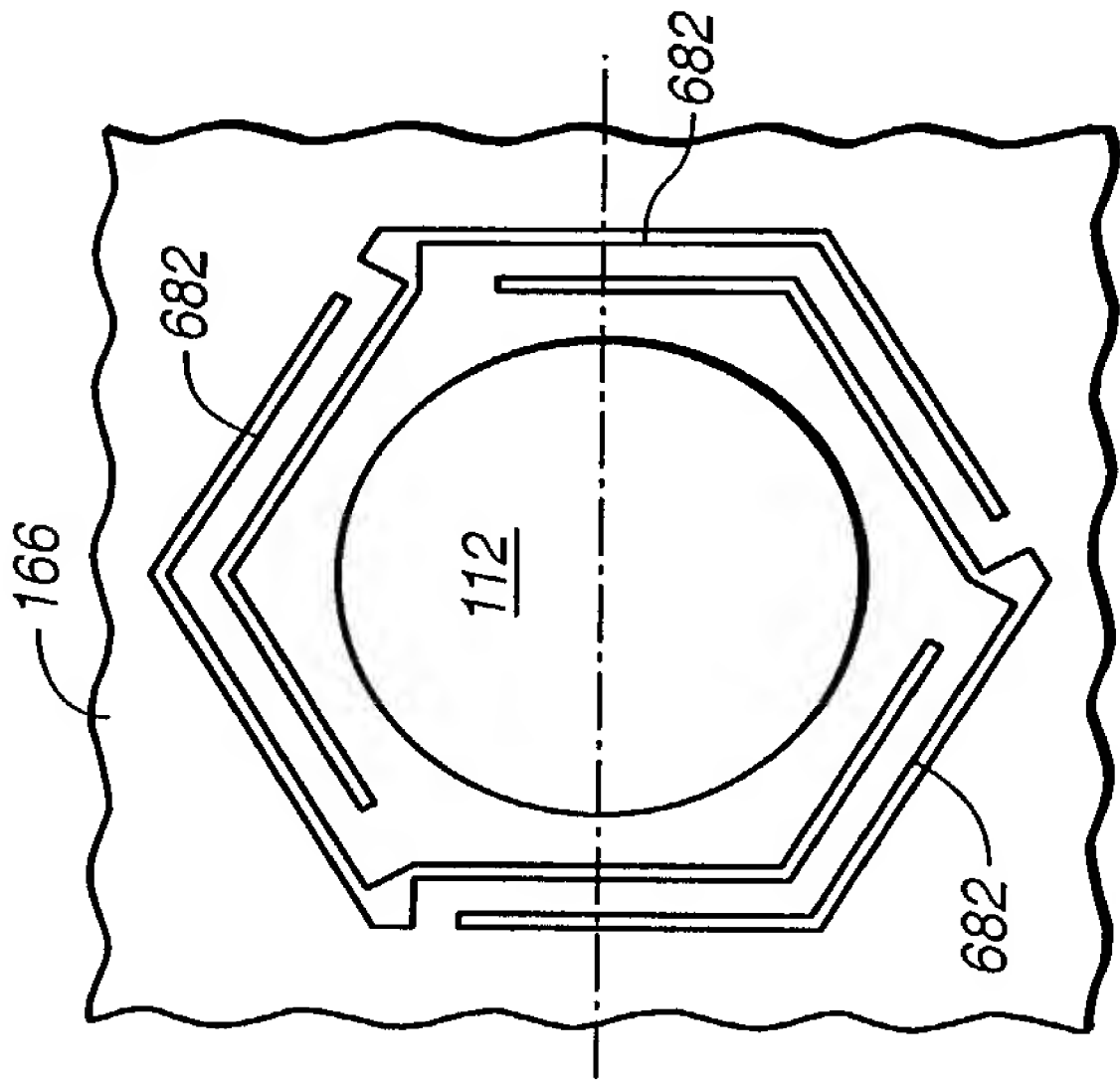


FIG. 30b

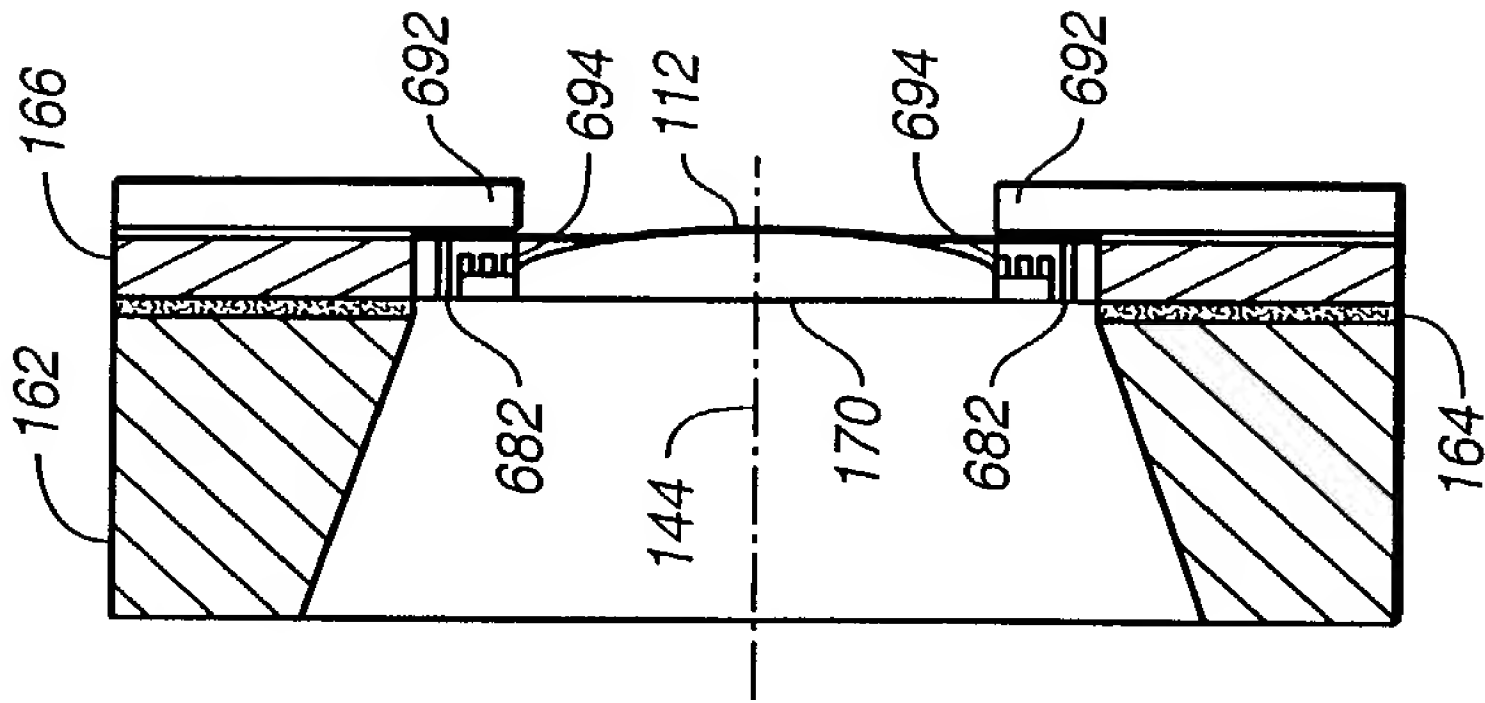


FIG. 30c

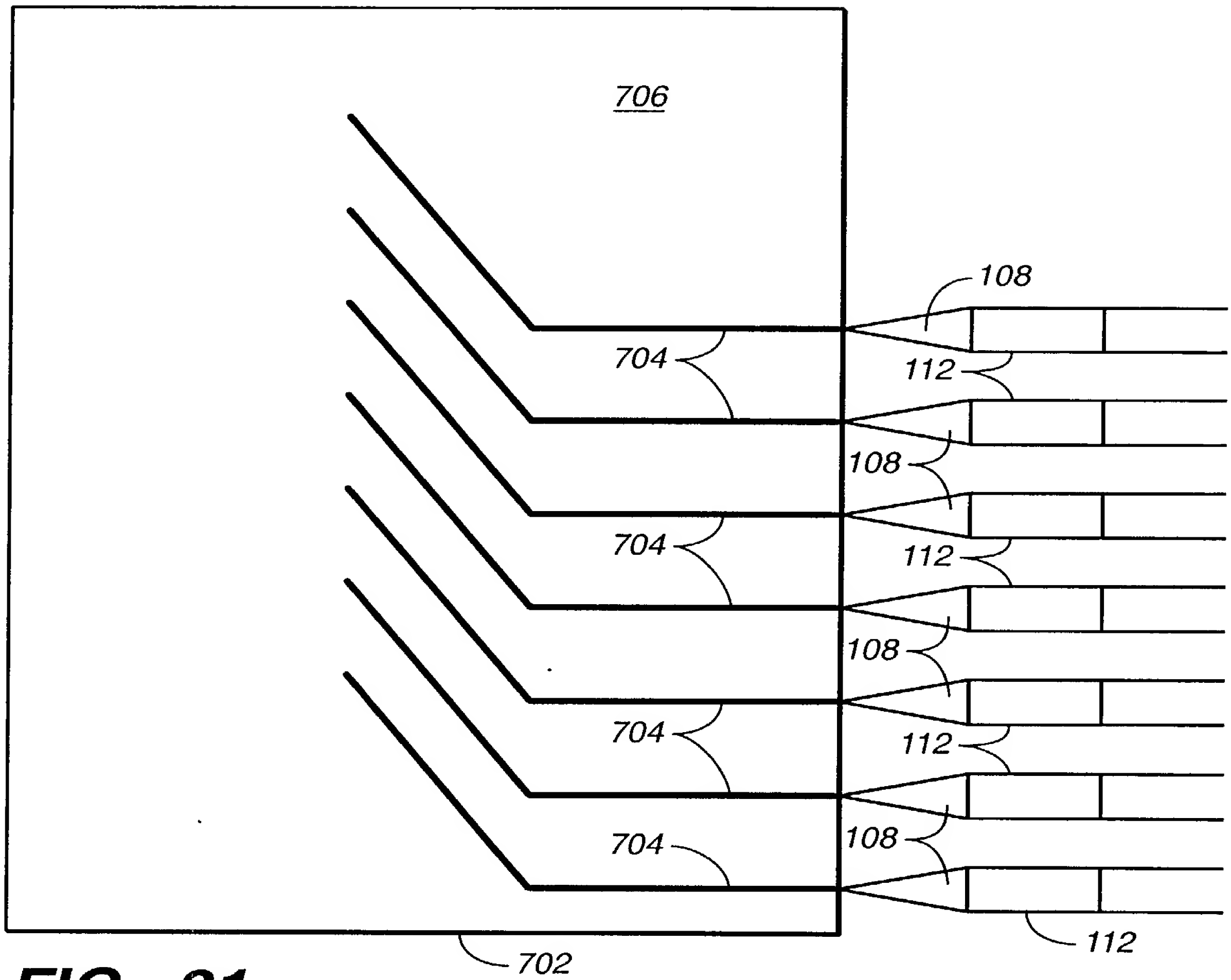


FIG._31